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AT

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Bulletin of the Museum of Comparative Zoology

AT HARVARD COLLEGE

Vol. 129, No. 1

MIDDLE ORDOVICIAN TRILOBITES FROM LOWER HEAD, WESTERN NEWFOUNDLAND

By H. B. Whittington

With 36 Plates

CAMBRIDGE, MASS., U.S.A.

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No. 1 — *Middle Ordovician Trilobites from Lower Head, Western Newfoundland*

By H. B. Whittington

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INTRODUCTION AND ACKNOWLEDGEMENTS

At the tip of Lower Head, western Newfoundland (Text-fig. 1) is a cliff cut in the white limestone of a single enormous boulder in a conglomerate. From this cliff have been obtained many hundreds of beautifully-preserved specimens of trilobites, here grouped into forty-five species. Almost all these species are unique to this locality, as are seven of the twenty-six genera recognised. Most of the remaining genera appear for the first time in North America at this stratigraphical horizon, early Middle Ordovician, Whiterock stage. It is thus a most unusual fauna, and my interest in trilobites of western Newfoundland began when Prof. Ceeil H. Kindle showed me collections he had made prior to 1952 from this locality. Since 1955 he and I have collaborated in an investigation of the stratigraphy and

trilobite faunas of this region (Kindle and Whittington, 1958, 1959). The collections we have made, together with earlier ones by Kindle, have afforded the bulk of the material described herein. All the species listed under "Numbers of Specimens" are described herein, with the exception of the Pliomeridae, dealt with earlier (Whittington, 1961b). Illustrations of *Selenoharpes fragilis* (Pl. 1, figs. 18-20; Pl. 2, figs. 1-3) from Stearing Island, of *Nileus affinis* (Pl. 9, figs. 7, 11, 12; Pl. 10, figs. 1-3, 5, 6) from Quebec, of *Lloydia saffordi* (Pl. 11, figs. 13, 16-18) possibly from a different boulder at Lower Head, of *Lehua vincula* (Pl. 23, figs. 10, 12) from Bohemia, and of *Cheirurus polydorus* (Pl. 25, fig. 10) from Portland Creek, are the only ones on the Plates not from Lower Head.

In 1861 and 1863 James Richardson explored the west coast of Newfoundland for the Geological Survey of Canada, measuring sections and collecting fossils. This material was described by Elkanah Billings (1861-1865), and when I visited Ottawa in 1954, I studied and photographed it. The specimens which Kindle and I have collected from Lower Head are identical with certain that Billings recorded as from "Cow Head" (Text-fig. 1), the horizon as "Division P, Quebec Group." The latter is the designation (Billings, 1865, pp. 207-208, 373-377) for the conglomerates of western Newfoundland. Through the kindness of Dr. D. J. McLaren and L. M. Cumming, Geological Survey of Canada, I obtained photostatic copies of Richardson's field notes of 1861 (Geol. Surv. Canada, no. 1493). These contain, on pages 116-119, an account of a supposed ascending geological section, beginning at Sandy Bay (Text-fig. 1) and proceeding southward to Cow Head harbour. At the top of this section conglomerates are described in which are "large masses . . ." of a "coarse granular limestone without any appearance of bedding" . . . it is "very uniform both in texture and colour, in some parts it holds in great abundance a large convoluted shell with trilobites generally in a fragmentary state." This is the only mention of trilobites in the section, and large gastropods do occur in boulders adjacent to the white boulder at Lower Head (Kindle and Whittington, 1958, text-fig. 8). Richardson's notes go on immediately to describe the conglomerates on each side of Cow Head harbour (i.e. at White Rock Islets and Cow Head). Thus the passage quoted can hardly refer to anywhere but Lower Head, so that Richardson's fossils most probably came from the same locality as ours, which is prominent and easily

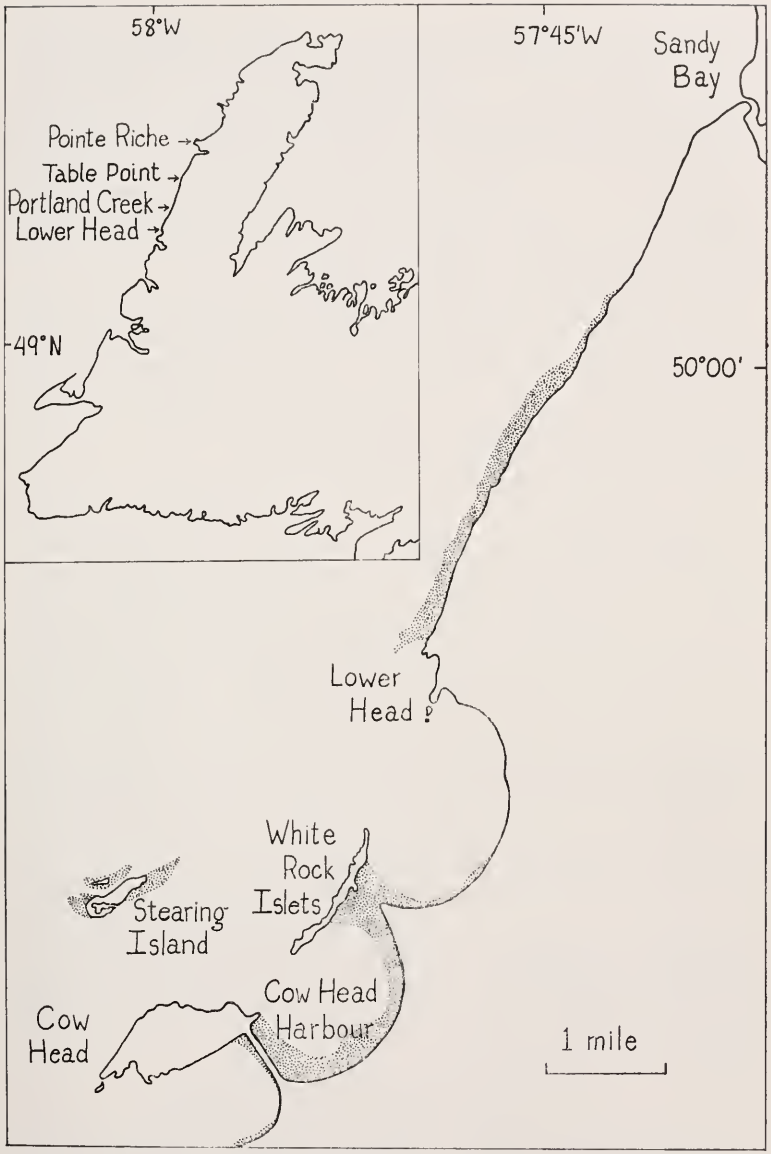

FIG. 1. Map showing Lower Head and adjacent localities mentioned in the text. Inset shows Lower Head and more distant localities on the west coast of Newfoundland.

reached from the sea. We have found one or two boulders of white limestone, containing some of the Lower Head species, in conglomerate bed 14 on Cow Head (Kindle and Whittington, 1958, p. 326). Only at Lower Head have we found all but one of twelve species described by Billings and based on material from "Cow Head" (Billings, 1865, p. 375, lists 17 species of trilobites from "Cow Head," but five of these are not based on material from this locality). In our collections these species are present in the abundance and manner of preservation of those in Richardson's original collection.

Lower Head was visited by C. Schuchert and W. H. Twenhofel in 1910, and by C. O. Dunbar in 1918. Their collections were described by Raymond (1925), including the type species of two new genera and additional specimens of Billings' species. Through the kindness of Prof. Karl M. Waagé I have examined this material and photographed the types.

This work has been made possible by several grants, for which I am deeply grateful. Funds from the Harvard Foundation for Advanced Study and Research enabled me to visit Ottawa in 1954, and I am indebted to Dr. H. Frebold for permitting me to study and photograph Billings' types. Field work in Newfoundland, by Kindle and me, was carried out in 1955 under Geological Society of America grant 671-55, in 1958 and 1961 under National Science Foundation grant G-4189. In the field we have had the enthusiastic assistance of Mrs. Whittington, and her efforts have added greatly to our collections. The cost of publication of the plates, and part of the costs of binding, have been borne by National Science Foundation grant G-19082. To Cecil Kindle I owe the inspiration that took me to Newfoundland, and I am further in his debt for turning over to me his earlier collections, on which he has done considerable work. Mr. Ronald P. Tripp has been most helpful in personal correspondence regarding the affinities of the lichid. Miss Susan Fenollosa and Miss Eleanor Ardiff have prepared enlargements from my negatives and aided in mounting the plates. Mr. N. Strekalovsky prepared Text-figures 2-6.

OCCURRENCE OF THE FOSSILS

All the fossils described herein have been collected from the enormous (600 feet long by 200 feet wide) white limestone boulder at the tip of Lower Head (Text-fig. 1). The stratigraphy of the containing conglomerate has been described by

Kindle and Whittington (1958, pp. 334-335, pl. 4, fig. 2; text-fig. 8).

The sea has cut an erosional platform, covered at high tide, in the southern half of the boulder. Behind the beach is a cliff, some 20 feet high, cut in the white, fine-grained, irregularly-fracturing limestone of this part of the boulder. The flat cliff-top is grass-covered, and affords little exposure of the remaining northern portion. In the cliff, fossils occur in scattered patches, frequently close to calcite-filled geodes. The entire collection (and most probably earlier ones) has been obtained from these patches in this small cross-section, 200 feet long, of the boulder. A cursory examination of the southern half showed that it was white or light-brownish in colour, some parts granular and obscurely bedded, with apparently few fossils. The fossiliferous patches in the cliff yield abundant trilobites and relatively few brachiopods and gastropods. Occasionally large cephalopods have been observed. The limestone is unbedded, and the collection has been amassed from chips pried out and broken up in the laboratory. Thus selective collecting is hardly possible, and the list below gives an approximate idea of relative abundance. Entire exoskeletons are rare, even of the common species. The abundance of isolated cephala and pygidia suggests that the exoskeletons (either moults or of dead individuals) were subjected to sufficient current action to disarticulate them and sort them before they were deposited in patches. Individual accumulations (Pl. 36, fig. 9) are never solely of one species, but a mixture of the common forms (e.g. *Bathyurellus nitidus, Illaenus tumidifrons, Cydonocephalus prolificus, Apatolichas jukesi*) with a few of the others. It is clear that the resistance to disarticulation varies with the kind of trilobite — *Geragnostus clausus* n. sp. is exceptionally resistant, the common cheirurids and illaenids, and the lichid, much less so.

The pure, fine-grained, unbedded limestone of the boulder is suggestive of a reef-core rock, like that of the Upper Ordovician limestone reefs of Dalarna, Sweden (Thorslund, 1936; 1960, pp. 91-93). It is notable that in the Swedish limestones fossils also occur in scattered patches, individual patches yielding abundant shells of only one species, or species of one genus. Such patches may be interpreted as having accumulated in an original cavity in the reef in which the particular species was living. The fossiliferous patches at Lower Head do not appear to be analogous, but to be drifted and sorted accumulations.

The excellence of the preservation shows that abrasion did not occur, and individual cephala and pygidia are usually complete, not in fragments. It seems that the exoskeletons must have accumulated near where the animals lived, but that sorting occurred, for the smallest growth stages have not been found, and larger meraspides are rare.

NUMBERS OF SPECIMENS

Well over a thousand specimens in the collections made by Kindle and me have been identified and counted in compiling the following list. It gives an approximate idea of relative abundance, since blocks of the limestone were broken in the laboratory and all recognisable specimens kept.

	Complete exoskeletons	Cephala or cranidia	Pygidia
Agnostidae			
Geragnostus clusus n. sp.	10	12	15
Harpidae			
Selenoharpes vitilis n. sp.		58	1
Remopleuridiidae			
Remopleurides ligulus n. sp.		7	
Proetidae			
Phaseolops sepositus n. sp.	15	54	3
Isocolidae			
Isocolus dysdercus n. sp.	12	108	14
Isocolidae ?			
Idiorhapha solitaria (Billings)		1	
Dimeropygidae			
Ischyrotoma twenhofeli Raymond	2	9	
Ischyrophyma tuberculata n. sp.		16	
Ischyrophyma ? sp. ind.		1	
Cephalon gen. ind.		1	
Glaphuridae			
Glaphurus divisus n. sp.		21	
Nileidae			
Nileus affinis Billings		1	1
Bathyuridae			
Bathyurellus nitidus Billings	26	135	56
Uromystrum fraternum (Billings)		5	4
Uromystrum formosum (Billings)		4	
Uromystrum patulum n. sp.	1	14	4
Goniotelus perspicator (Billings)		2	
Goniotelus kindlei n. sp.	?	30	8
Goniotelus rostratus n. sp.		17	
Goniotelus sp. ind.		1	

	Complete exoskeletons	Cephala or cranidia	Pygidia
Illaenidae			
Illaenus tumidifrons Billings	22	309	60
Illaenus consobrinus Billings		110	17
Illaenus bucculentus n. sp.		12	
Illaenus sp. ind. 1		5	
Illaenus sp. ind. 2		1	
Illaenus spiculatus n. sp.	2	33	
Harpillaenus arcuatus (Billings)		39	20
Scutelluidae			
Perischoclonus capitalis Raymond		10	2
Cheiruridae			
Lehua argus n. sp.		5	
Heliomera albata n. sp.		9	
Heliomeroides alacer n. sp.		7	
Kawina vulcanus (Billings)		11	
Kawina limbata n. sp.		13	
Kawina arnoldi n. sp.	1	31	6
Cydonocephalus griphus n. sp.		28	
Cydonocephalus torulus n. sp.		38	
Cydonocephalus scrobiculus n. sp.		20	
Cydonocephalus prolificus (Billings)		189	
Cydonocephalus mercurius (Billings)		0	
Cydonocephalus prominulus n. sp.		8	
Kawina ? sp. ind.			2
Pygidium gen. ind. 1			14
Pygidium gen. ind. 2			9
Pygidium gen. ind. 3			4
Pygidium gen. ind. 4			5
Pliomeridae			
Ectenonotus sp. ind.		1	1
Pseudomera billingsi Whittington		4	3
Colobinion julius (Billings)		32	9
Pygidium gen. ind.			1
Odontopleuridae			
Ceratocephala exigua n. sp.		7	
Lichidae			
Apatolichas jukesi (Billings)	2	272	48

AGE OF THE FAUNA

Kindle and Whittington (1958, pp. 334-335, pl. 4, fig. 2; text-fig. 8) have shown that the conglomerate containing the white limestone boulder at Lower Head rests on black shales containing graptolites. These graptolites are typical of zone 8 of Berry

(1960a), i.e. of high Deepkill or high Lévis Shale age, an age that has been equated with part of the Whiterock stage by Kindle and Whittington and by Berry. The conglomerate is overlain, apparently conformably, by a sequence of green sandstones from which no fossils have been obtained. These are the highest beds in the succession, so no upper limit for the age of the boulders in the conglomerate can be given.

No white limestone containing the fauna of the great boulder at Lower Head has been found in a regularly-bedded sequence in western Newfoundland. However, thirty miles north of Lower Head is Table Point (Text-fig. 1), where is exposed the type section of the Table Head Formation (Schuchert and Dunbar, 1934, pp. 63-65, 68-69). Some trilobites from the dark, muddy limestones of the Table Head Formation have been described by Billings (1861-65), Raymond (1925), and Whittington (1961b). Extensive new collections from the type section have been made by Kindle and me, and preliminary examination of these collections shows that:

1) The species of *Uromystrum*, *Goniotelus*, *Nileus*, *Eetenonotus* and *Pseudomera* that occur in the lower part of the Table Head are like, but not identical with, those from Lower Head;

2) In the middle part of the Table Head Formation occur species of *Geragnostus*, *Selenoharpes*, *Remopleurides*, *Nileus*, *Heliomera* and *Pseudomera* that again are like, but not identical with, those from Lower Head. Other trilobites, such as asaphids, raphiophorids, species of *Harpides*, *Telephina*, *Triarthrus*, *Raymondaspis*, and "*Cybele*" that are common in the middle part of the Table Head, are unknown in the boulder at Lower Head. The illaenids in the two deposits are also quite different.

Dr. G. Arthur Cooper kindly examined the small collection of brachiopods from Lower Head, and identified *Pleurorthis* sp., *Porambonites* ? sp., and *Camerella* sp. The type and three additional species of *Pleurorthis* are from boulders at Mystic, Quebec, and other species are from boulders at Lévis, Quebec, the Cow Head Group, and from the Table Head Formation (Cooper, 1956, pp. 329-333, pl. 31, figs. 11-29, pl. 32, figs. 1-6). Shells referred to *Porambonites* ? by Cooper (1956, pp. 608-611, pl. 106, figs. 17-24; pl. 107, figs. 1-11, pl. 108, figs. 40-42) are from beds of Whiterock age in Nevada and California and from the lower part of the Table Head. *Camerella* is a long-ranging genus, one species of which, from Lower Head, was described by Cooper (1956, p. 582, pl. 111, figs. 36-40).

The similarities between the fauna at Lower Head and those of the Table Head Formation is here taken to indicate a general equivalence in age (cf. Raymond, 1925, pp. 166-167). *Ectenonotus* has not been found in the middle part of the Table Head Formation, where many new kinds of trilobites, unknown at Lower Head, make their appearance. The equivalence may therefore be with the lower part of the formation. The differences between the faunas may be due in large part to differences in the environment of deposition — the Table Head limestones are not only dark in colour and muddy, but contain at various levels abundant sponges, gastropods and ostracods.

Graptolites have been collected from the upper part of the Table Head, and Dr. W. B. N. Berry informs me (personal communication) that they are representative of his zone 9, which he places at the boundary between the Whiterock and the overlying Marmor Stage (Berry, 1960a, p. 37, table 2). Thus the graptolites reinforce the conclusion drawn from studies of brachiopods (Cooper, 1956) and trilobites (Whittington, 1961b) that the Table Head Formation is equivalent in age to the Whiterock beds of Nevada. It is because of this correlation that the Lower Head trilobite fauna is regarded as being Whiterock in age.

Correlation of the Whiterock Stage with European stages is still being debated. Kindle and Whittington (1958, p. 338, text-fig. 4) and Berry (1960a, p. 43, table 3; 1960b, p. 102, table 1) correlate the Whiterock with at least part of the Llanvirn, Berry equating the base of the two stages. Bulman (1958, p. 166) equates the "*bifidus* zone of eastern North America," i.e. Berry's zone 7, with the Upper Arenig of Britain. Zone 7 is apparently of about the same age as the lower part of the Whiterock (Berry, 1960a, pp. 19, 37), and Bulman's correlation implies that the early Whiterock is late Arenig in age. Jaanusson (1960b, pp. 295, 355-356) inclines to this latter view, but points out the indefinite nature of these correlations, which are based on considerations of graptolite faunas. As the succeeding section shows, trilobite faunas do not afford a more precise basis for correlation, though I have adopted that suggested by Kindle and me.

EVOLUTIONARY AND GEOGRAPHICAL RELATIONSHIPS

Summary

The Lower Head trilobite fauna, of Whiterock age, is almost unique specifically. New to North America are 89 per cent of the genera. About one-half may be descended from North American stocks. Many of the remainder belong to new and rapidly evolving families that come to dominate younger faunas. Three of these exotic genera are known in older or contemporaneous rocks in Europe. The area of origin of the new families is unknown, but genera belonging to them migrated into different areas at about the same time.

In Upper Canadian (Upper Arenig) time three trilobite provinces may be recognised, a North American bathyurid province, a Baltic asaphid province, and a central and southern European calymenid-trinucleid province (Text-fig. 2). Few genera are common to all of these provinces. In Whiterock (Llanvirn and slightly younger time) the American and Baltic provinces remained distinct, characterised by their endemic genera, but with a few elements in common. Both show new generic groups of unknown origin. The calymenid-trinucleid province is recognisable through central Europe, south to Morocco, and west to Florida, and contains many distinctive elements. Yet in Llanvirn time new genera of the same families as those that were new to the other provinces entered the central and southern European province. A striking link between provinces is the presence of *Lehua* in both Bohemia and Newfoundland.

Relationships

Of the 45 species (including indeterminate forms) listed above, over half are new, and all but three are unique to the locality. Of these latter, *Idiorhapha solitaria* and *Goniotelus perspicator* were first found in another boulder of white limestone near St. Antoine de Tilly, Quebec (Whittington, 1953b, pp. 674-675; Dr. L. M. Cumming, Geological Survey of Canada, kindly searched through J. Richardson's field notebooks, but found no mention of this boulder). Whether this boulder was from a conglomerate or in glacial drift is not known. The types of *Nileus affinis* presumably came from a boulder in conglomerates on the Island of Orleans, near Quebec City. The Cambrian

trilobites from boulders in conglomerates in western Newfoundland are remarkably like those from conglomerates near Quebec City and along the south shore of the St. Lawrence (Kindle and Whittington, 1958, p. 339). Seemingly this relationship, over a distance of 800 miles, continued into Middle Ordovician times, as Billings (1865, p. 376) clearly recognised.

Of the twenty-six genera recognised, the five new ones, and in addition *Perischoclonus* Raymond, 1925, and *Colobinion* Whittington, 1961b, are based on species peculiar to the Lower Head boulder. Two more, *Idiorhapha* and *Goniotelus,* are known only from it and the St. Antoine de Tilly boulder. Nine genera, *Ischyrotoma, Glaphurus, Bathyurellus, Uromystrum, Heliomera, Heliomeroides, Kawina, Ectenonotus* and *Pseudomera* are known elsewhere in North America, Greenland and western Ireland, the first-named from older rocks, the others from contemporaneous or younger strata. Six genera, *Geragnostus, Selenoharpes, Remopleurides, Nileus, Illaenus* and *Ceratocephala,* are well-known from other continents, the first two from older rocks both in North America and Sweden (Tjernvik, 1956). *Nileus* and *Illaenus* occur in rocks of Arenig age in Sweden (Tjernvik, 1956; Jaanusson, 1957) but not in North America until the Whiterock Stage. *Remopleurides* and *Ceratocephala* become widespread in North America in the younger Marmor and Porterfield stages, and *Remopleurides* is well known in Scandinavia in younger (Llandeilo) rocks ($4a\alpha_4$ of Norway, Størmer, 1953, p. 83; *crassicauda* limestone of Sweden, Jaanusson 1960a, p. 278). Two genera, *Isocolus* and *Lehua,* are otherwise known only in Europe — *Isocolus* in the Upper Ordovician Boda limestone of Sweden, and *Lehua* from upper Llanvirn rocks of Bohemia.

The Lower Head trilobite fauna may be characterised as almost unique specifically. At the generic level, 89 per cent are new to North America, *Geragnostus, Selenoharpes* (probably), and *Ischyrotoma* being present in Canadian rocks. Of the new elements (23 genera), eight may well be derived from genera of families indigenous in Canadian rocks of North America — *Ischyrophyma* from older dimeropygids such as *Ischyrotoma, Goniotelus, Bathyurellus* and *Uromystrum* from older bathyurids, *Colobinion, Ectenonotus* and *Pseudomera* from earlier pliomerids, and *Remopleurides* from Canadian remopleuridids. Illaenids and odontopleurids are varied in the Lower Ordovician of Sweden (Jaanusson, 1957; Whittington and Bohlin, 1958), while representatives of both families are present but little known in rocks of similar age in North America (Hintze, 1953,

pl. 19, figs. 16a,b; Kindle and Whittington, 1958, pp. 324-325). Whether or not the illaenids and odontopleurid from Lower Head are derived from indigenous or exotic stocks is thus uncertain. *Isocolus*, and perhaps *Idiorhapha*, may be descended from American late Cambrian catillicephalids. Thus, about half the genera present may be regarded as North American in origin and relationships. The remainder are exotic. The presence of *Nileus* and *Lehua* indicates a connection with certain European areas, and nileids, scutelluids, and lichids are present in Lower Ordovician rocks in Europe but not North America. *Phaseolops* and *Glaphurus* are members of families unknown in older rocks. These exotic elements are largely members of families that became widespread in later Middle Ordovician stages in North America.

Faunal Provinces

If the Lower Head fauna and slightly older and younger North American faunas are compared with contemporaneous faunas in Europe, three generalised areas of distribution become evident (Text-fig. 2). For this comparison it is assumed that the Lower Head fauna is Whiterock or approximately Llanvirn in age. Sources for data on European trilobites include appropriate fascicules of the "Lexique Stratigraphique International," vol. 1; Gobbett and Wilson, 1960; Henningsmoen, 1960; Jaanusson, 1960a; Reed, 1945; Sdzuy, 1958; Størmer, 1953; Thoral, 1935; Tjernvik, 1956; and Whittard, 1955-1961. Sources on North America include Hintze, 1953; Ross, 1951, 1958; Poulsen, 1927, 1937, 1951; Cowie and Adams, 1957; Whittington, 1953b. The source of data for Argentina is Harrington and Leanza, 1957.

Upper Canadian (= *Upper Arenig*). In North America, from eastern Nevada, western Utah, through Oklahoma, the Appalachians, Newfoundland and northwest and east Greenland, harpids, *Ampyx*, hystricurids, komaspids, asaphids, bathyurids and pliomerids are found, dominantly in limestones. The occurrence of *Petigurus* in north-west Scotland, of a bathyurid in the Trondheim area, Norway, and of bathyurids and hystricurids in Spitsbergen, shows that this province extended to the northwestern margin of Europe. In southern Norway and Sweden, again dominantly in limestones, harpids, numerous quite different kinds of asaphids, illaenids, the bathyurid *Agerina*, *Ampyx*, *Nileus*, *Pliomera* and *Raymondaspis* occur. In central Britain, in clastic rocks, occur *Geragnostus*, *Ampyx*, trinucleids, asaphids,

an illaenid, *Shumardia*, cyclopygids, calymenids, *Placoparia* (a pliomerid), and *Selenopeltis*, a peculiar odontopleurid. The Arenig of Bohemia is not well known, but the occurrence of *Euloma* and *Nileus* suggests Scandinavian affinities. In the

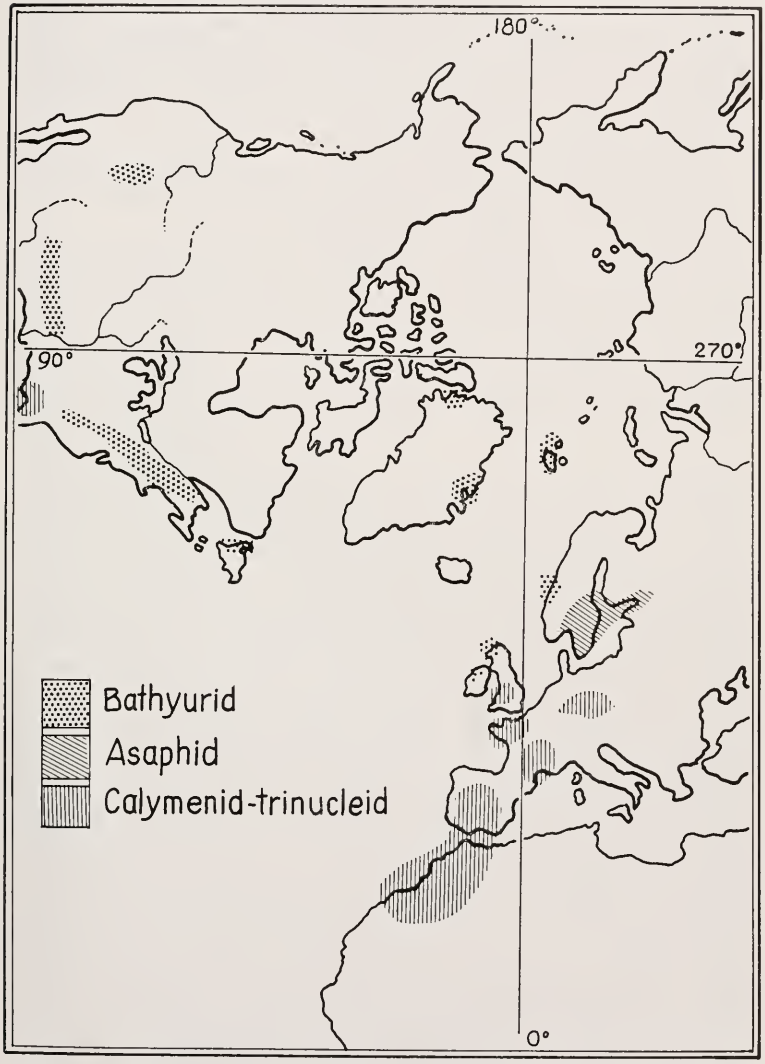

FIG. 2. Distribution of similar trilobite faunas in the Lower and early Middle Ordovician rocks of North America and western Europe.

Montagne Noire *Euloma*, *Symphysurus*, an illaenid, and asaphids supposedly related to some from Sweden, are recorded. These again suggest Scandinavian affinities, but calymenids and cyclopygids also occur, like those known from Britain. Text-figure 2 shows three areas of distribution, an American bathyurid, a Baltic asaphid, and a central and southern European calymenid-trinucleid area. The latter is less clearly characterized in Arenig time than it is in the Llanvirn-Llandeilo. *Geragnostus* and *Ampyx* may be common to all three areas, and possibly *Selenoharpes* to the American-Baltic.

Arenig trilobites of Argentina are not of the bathyurid province, but include asaphids and other elements (*Shumardia* and *Pharostomina*) of central European type.

Whiterock (= *Llanvirn*). Some of the Lower Head elements appear in the less well-known faunas of Oklahoma and Nevada — the pliomerids, *Nileus*, certain cheirurids and an illaenid. There are suggestions of these faunas in E. Greenland and the Trondheim area of Norway (Spjeldnaes, 1961) and a remarkable occurrence of Whiterock trilobites in western Ireland (Reed, 1945; Stubblefield, 1950; *"Bathyurellus" glensaulensis* is probably a species of *Uromystrum*, and the fauna includes also *Nileus*, *Illaenus*, *Carolinites*, *Telephina*, a probable pygidium of *Kawina*, and *Ectenonotus*). In southern Scandinavia asaphids are again important, accompanied by *Illaenus*, *Pliomera*, *Lichas*, and new odontopleurids. From southern Norway *Telephina* and *Trinucleus* are recorded, the former common in the middle Table Head Formation, the latter known in Britain. The rich fauna of the British and Bohemian Llanvirn is again calymenid-trinucleid, new genera appearing in these two groups. These are accompanied by agnostids, raphiophorids, dionidids, cyclopygids, asaphids, illaenids, nileids, scutelluids, the pliomerid *Placoparia*, encrinurids, dalmanitids, *Selenopeltis* and *Triarthrus*. The latter is present in the middle Table Head. The Llanvirn of Argentina contains asaphids, calymenids, and trinucleids suggestive of central European relations, but there are new elements — cheirurid, pliomerid, encrinurid, and the bathyurid, *Proetiella*.

In general, in the Whiterock-Llanvirn, the provinces retain their distinctive characters as new genera of typical families evolve. Notable among new genera are those of illaenids, scutelluids, cheirurids, pliomerids, encrinurids, lichids or odontopleurids. These are evidently relatively new and rapidly evolving groups which were entering all the provinces.

Marmor-Ashby (= *high Llanvirn-Llandeilo*). The Chazyan of New York and the Mingan Islands, and the Lincolnshire Limestone of Virginia (Whittington, 1959, p. 338), contain such elements of the Lower Head faunas as *Remopleurides, Glaphurus, Heliomeroides* and possibly *Uromystrum* and *Kawina,* together with new illaenid, asaphid, dalmanitid, cheirurid, encrinurid, pliomerid and lichid genera. In southern Scandinavia are quite different asaphids, and trinucleids in Norway, and few genera in common with N. America. In Britain and Bohemia there is an asaphid-calymenid-trinucleid fauna with many additional forms — illaenids, dalmanitids, cheirurids, odontopleurids, lichids — unlike any known to the north and west. The *Nescuretus-Colpocoryphe* fauna of this province is also encountered in northwestern and southern France, Portugal, Spain and Morocco. Surprisingly, *Colpocoryphe* appears in subsurface beds of Florida (Whittington, 1953a) and suggests a western extension of the province. Thus the North American and Scandinavian provinces can still be recognised, differentiated by their endemic groups but with some common elements. The central and southern European, North African, and Florida province is distinct.

Discussion. The outlines of these provinces were recognised by Stubblefield (1939). The differences between them in Canadian (Arenig) time are well shown by the illustrations of Ross (1951) and Hintze (1953) of trilobites of the bathyurid province, Tjernvik (1956) of the asaphid, and Whittard (1955-1961) of the calymenid-trinucleid. In part during this time the differences are at the family level — hystricurids, dimeropygids and komaspids (*Carolinites*) being peculiar to the bathyurid province, nileids to the asaphid, and trinucleids and calymenids to the province named for them. Other families, such as asaphids, bathyurids, illaenids, pliomerids, and odontopleurids are represented by quite different genera in two or more provinces. It is such differences as these, together with differences in abundance of particular groups, that characterise these provinces. Many factors have operated to bring about the distributions we can trace today. Among these factors are: (i) the area in which a particular taxonomic category arose; (ii) the nature of the environment in which the deposits were formed; (iii) the ability of particular species to exist in these environments; and (iv) the forces controlling possible routes of migration. Until the picture can be clarified and extended in time and space it will remain difficult to sort out the relative importance of different

factors at different places and times. The relation between morphology and environment, i.e. adaptation, is poorly understood in trilobites. That no barrier impassable to trilobites separated the provinces is shown by the presence at about the same time of similar species of *Geragnostus* and *Ampyx* in all of them, of *Lehua* in Bohemia and Newfoundland (Pl. 23), and of *Selenecceme* in Shropshire (Whittard, 1960, pp. 117-120, pl. 16, figs. 1-5), Newfoundland (Kindle, 1942) and Quebec (Whittington, 1952, p. 4, pl. 2, fig. 13). Other genera, such as *Nileus* and *Illaenus,* are present first in one province (in this case the Arenig of the Baltic) and apparently migrated to other provinces. Another possible case of such migration is afforded by species of *Pliomerops,* the type species of which is widespread in Chazyan rocks of eastern North America (Whittington, 1961b, p. 917, pl. 101, figs. 10-13, 16, text-fig. 2). This genus has been claimed to be present in rocks of Tremadoc to Llanvirn age in Bohemia (Přibyl, 1953, p. 57), and the Llanvirn species *P. senilis* Barrande (1872, pp. 118-119, pl. 5, figs. 25, 26; pl. 8, figs. 23-25) is very like the type species in dorsal aspect, though there are only 14, not 18, thoracic segments. The rostral plate (as shown by specimens numbered MCZ 488) is subtriangular, not trapezoidal, and the hypostome different in form. Is *P. senilis* the ancestor of the Chazyan *P. canadensis,* or a remarkable example of parallel evolution? Is it more reasonable to regard *P. canadensis* as derived from the older North American inhabitant of the same province, *Pseudomera barrandei* (Whittington, 1961b, pp. 917-918, pl. 100, figs. 6-8, 10)? Problems like this give one pause in speculations about origin, evolution and supposed migrations between faunal provinces.

Ordovician faunal provinces in western Europe and America have recently been discussed by Spjeldnaes (1961), who outlines seven provinces in the Arenig of Europe, and six in the Llanvirn-Llandeilo, his discussion of them being under three headings. His "American-Aretic" province roughly corresponds to my "bathyurid" area. Spjeldnaes' "Appalachian and Anglo-Scandic" provinces, however, are based on considerations of rocks of post-Ashby (i.e. *N. gracilis* and younger) age, which are younger than any I consider here. I do not think that "Seoto-Appalachian" type faunas should be shown as occupying a province distinct from that of the "American-Aretic" faunas in Arenig and Llanvirn-Llandeilo time, as Spjeldnaes shows them in his text-figures 1 and 2. We are agreed that central European and Baltic faunas are different during these

times, and on the extent of the Llanvirn *Nescuretus-Colpocoryphe* province. Spjeldnaes suggests that the faunal provinces may reflect the climatic zones of the time.

The existence of these provinces makes correlation difficult, and since the graptolites also show provincial differences at these times (Berry, 1960b, p. 106), the difficulties are intensified. It seems clear that, in early Middle Ordovician (Whiterock-Llanvirn) times new groups of trilobites were diversifying and entering the various provinces. The exotic elements of the Lower Head fauna include these newcomers — notably cheirurids, the odontopleurid and the lichid.

MORPHOLOGY AND CLASSIFICATION

The systematic section provides detailed descriptions of the morphology of the exoskeletons, revealed by the excellent preservation, and the taxonomic conclusions derived from this information. In this summary attention is drawn to certain morphological features of general interest, and to other such features that raise particular taxonomic problems.

Morphology

Hypostome. A few specimens showing the hypostome in position have been found. These are of one species of *Kawina* (Pl. 27, figs. 1, 4), two species of *Cydonocephalus* n. gen. (Pl. 27, figs. 7, 12, 15, 19; Pl. 29, figs. 2, 3, 6), and one of *Apatolichas* (Pl. 33, figs. 1, 2, 5). The hypostome of the latter is remarkable in that the posterior border projects back to lie beneath the first thoracic segment (Text-fig. 6).

Enrollment. The close fit of the exoskeleton during enrollment is well shown by *Geragnostus clusus* n. sp. (Pl. 1, figs. 1-6, 13-17). The unusual form of the thoracic pleurae makes possible this close fit (Text-fig. 3).

Sexual dimorphism? Two types of cephalon are described in *Selenoharpes vitilis* n. sp., differing only in the form of the genal prolongation (compare Pl. 2, figs. 5, 7, with Pl. 3, figs. 1, 5). Two types of cephalon are also present in *Bathyurellus nitidus,* one with a rounded (Pl. 10, figs. 8, 11, 12, 14, 15, 17), and the other with a prolonged (Pl. 11, figs. 4, 6, 7, 12) genal angle. These differences in one character are not considered to be of specific rank. Differences in one or more characters between two trilobites occurring at the same horizon have been noted

(e.g. Hintze, 1953, p. 150; Whittington, 1959, p. 427), and it has been suggested that they may represent sexual dimorphs.

Classification

Significance of particular characters. The problem of what rank — specific or generic — to assign to differences in particular characters between groups of specimens, has arisen in a few cases. One such case concerns the new species of *Uromystrum, Goniotelus, Illaenus, Kawina* and *Cydonocephalus* n. gen. The several species of each of these genera are distinguished one from another by a number of such characters as outline, convexity, relative size and position of parts of the exoskeleton, depth of furrows, etc. Plate 28, figures 1-15, illustrates such differences between four species of *Cydonocephalus* n. gen. To assign to these differences a rank higher than specific appears unwarranted, though Palmer (1960, p. 58), in dealing with Upper Cambrian trilobites, has considered differences "in shape or outline of the border, frontal area or glabella" as of generic rank.

The number of thoracic segments has been used as a cardinal generic character in Illaenidae (Jaanusson, *in* Moore, 1959, pp. O 372-O 376). In my view *Illaenus spiculatus* n. sp. shows that this character alone should not be so used. I have not thought it important enough, either, to distinguish generically *Nileus affinis* from Swedish species of *Nileus.*

Doublure and ventral cephalic sutures. The type species of the new supposed proetid genus *Phascolops* is shown to have a triangular rostral plate (Pl. 4, fig. 11), though in geologically younger proetids this plate is transversely rectangular. In some specimens of *Bathyurellus nitidus* (Pl. 11, fig. 15) the connective sutures converge straight back to outline a triangular rostral plate. Typically in bathyurids the connective suture runs in a curve convex inward, the two sutures coming close together in some part of their course. The taxonomic significance of these features is uncertain, for the dorsal exoskeleton of each is typical of the family in which it is placed. Difficulties of this same kind in other trilobites have been discussed by Jaanusson (1956, p. 40).

Isocolus dysdercus n. sp. is shown to have facets on the eye surface, and the suture is either of levisellid or of asaphid type. In these respects my diagnosis (1956, p. 1194) of the family Isocolidae needs emendation.

In recent work on illaenids attention has been given to the form of the rostral plate, hypostome, and pygidial doublure. In the species considered here the rostral plate and pygidial doublure are known (Text-fig. 4) but not the hypostome. The use of these features in classification of this difficult group promises well, but we need to know them in many more species.

Incomplete exoskeletons. Classification of cheirurid genera is difficult or impossible without knowledge of the entire exoskeleton, but this is unknown in many described species and in all but one of the present species. Some new information on the cephalon of *Heliomera* is given, and the complete exoskeleton of a species of *Kawina* is described. Nine further kinds of cheirurid cephala, and a number of isolated pygidia, present taxonomic problems common in palaeontology. I have applied in part the familiar, unsatisfactory solution of making a new genus to include six of these species.

External surface and internal mould. The exoskeleton is completely preserved in some specimens, in others partially or wholly stripped off. In the latter case a mould of the inner surface is preserved. The thickness of the exoskeleton is not uniform, and commonly it is thicker at the grooves in the external surface. In such cases the internal mould exhibits deeper and broader grooves than those in the external surface of the exoskeleton. A striking case of this difference in appearance is afforded by specimens of *Apatolichas jukesi* (compare Pl. 34, figs. 10 and 11). The two extremes are so different that they were tentatively placed in separate subfamilies by Tripp (1957, p. 121).

Another example of such difference in appearance is given by specimens of *Geragnostus clusus* n. sp. (compare Pl. 1, figs. 1-5 with figs. 13-17). In this example axial, preglabellar and border furrows appear much deeper and broader in the internal mould.

Family Scutelluidae. If the cephalon and pygidium of *Perischoclonus* are correctly associated here, this genus is closely allied to *Bronteopsis*. It is suggested that these two genera, and *Stygina* and its allies, all be placed in the Scutelluidae.

Synonyms. The excellent preservation of new material of *Ischyrotoma* shows that it is probably a senior synonym of *Dimeropygiella*. I also suggest that *Aristoharpes* should be regarded as a synonym of *Selenoharpes*.

SYMPATRIC SPECIES IN THE FAUNA

The trilobite fauna from Lower Head is extremely diverse, in that ten families are each represented by one species of one genus. In the remaining five families ten additional genera are represented by one species each. In three of these families are other genera containing several species — three of *Uromystrum*, four of *Goniotelus*, six of *Illaenus*, three of *Kawina*, and six of *Cydonocephalus* n. gen. In the systematic section it is shown that each of these species can be distinguished by several characters of the cephalon. Further, there is sufficient range in size of specimens to demonstrate that species of particular genera are not growth stages one of another. The different species of each genus occur side by side in the rock (Pl. 36, fig. 9), and since the entire collection comes from a relatively small part of the boulder, there seems no reason to doubt their essential contemporaneity. The occurrence of the fossils (see above) suggests that after death the exoskeletons accumulated in drifted patches not far from their habitat. It therefore seems proper to regard these species as sympatric (see, for example, Cain, 1954, pp. 73-97), and to suggest that they inhabited different ecological niches, possibly in close proximity. If the Lower Head boulder is part of a reef-core, there may well have been a variety of environments in the reef. It is not claimed that the diversification into several species took place at the site of the supposed reef; indeed, there is no evidence as to their origin. They all belong to genera new to the area, and may have been, in whole or in part, brought into the area by successive invasions.

The trilobite fauna of the *Leptaena* (Kullsberg and Boda) reef-limestones of Dalarna, Sweden (Warburg, 1925, pp. 413-416), presents a similar aspect to that of Lower Head. It is diverse, includes a number of families represented by one species of one genus, and other genera, such as *Illaenus*, *Pseudosphaerexochus*, and *Amphilichas*, of which two to six species may occur at one locality. In his discussion of the palaeoecology of the Silurian reefs of the Great Lakes area, Lowenstam (1957, pp. 234-235) refers to the great numbers of species, for example, of particular genera of crinoids, characterising the wave-resistant stage of reef development. Again, Imbrie (1959, p. 375) describes the Devonian Alpena limestone as containing small and localised populations of eight species of the brachiopod *Strophodonta*. The Alpena limestone contains biohermal masses, and he regards the taxonomic diversity as reflecting a diversity of ecological

niches in the environment. These examples combine to suggest that sympatric species of certain genera characterise ancient reef environments.

SYSTEMATIC PALAEONTOLOGY

Almost all the trilobites described below are from the boulder at Lower Head, and this locality is fully described in the section on "Occurrence of the Fossils." The locality is not repeated, therefore, in text or plate explanations. Localities are given for specimens not from Lower Head, and for the specimens originally collected by J. Richardson of the Geological Survey of Canada. These are labelled as from "Cow Head," the horizon recorded as "Division P" of the Quebec Group, i.e. the conglomerates of western Newfoundland. As explained in the introduction, these fossils almost certainly came from the white limestone at Lower Head.

Types and figured specimens are in the collections of the Geological Survey of Canada (GSC) and the Peabody Museum, Yale University (YPM). GSC numbers 16145 upwards are from Kindle and Whittington's collection. The remainder of this collection is in the Museum of Comparative Zoology (MCZ). Catalogue numbers are preceded by the appropriate letters as given in parentheses. Since the list of numbers of specimens shows the amount of material available for study, it is not mentioned again under the descriptions.

Terminology

The terminology used here is the same as that employed recently (Whittington, 1959, p. 375 and references), and most of the terms are defined in Harrington, Moore and Stubblefield (*in* Moore, 1959, p. 0 117-0 126). I have used the term 'glabella' to include the occipital ring, and described paired structures in the singular. I have recently (1960, pp. 406-407, text-fig. 1) discussed terms applicable to the pygidium, and those applicable to lichids (1961a, p. 434). Jaanusson (1956, pp. 37-38, text-fig. 1) has defined some terms describing types of ventral cephalic sutures.

Terminology for describing agnostids has been given by Palmer (1955, pp. 87-88, text-fig. 1). A somewhat similar terminology is used by most authors and it has been followed here with minor modifications. Most important of these is the

use of occipital ring and lateral occipital lobes for the lobes termed basal glabellar by Palmer and other authors. Barrande (1852) referred to this ring, with its prominent lateral lobes, as the occipital ring, and since it is the most posterior part of the glabella it seems an appropriate term. I have preferred to use "border" furrow rather than "marginal" furrow, and to refer to a "median tubercle" rather than an "axial node."

Family AGNOSTIDAE M'Coy, 1849

Genus GERAGNOSTUS Howell, 1935

Type species. Agnostus sidenbladhi Linnarsson, 1869, redescribed by Tjernvik, 1956, pp. 188-189, fig. 27a, pl. 1, figs. 5, 6.

Discussion. Species of this genus have recently been described from Upper Cambrian rocks (Palmer, 1955, pp. 88-91, pl. 19, figs. 1-4; pl. 20, figs. 1-3, 12, 15; Rasetti, 1959, pp. 380-381, pl. 51, figs. 15-18), and Lower and Middle Ordovician rocks (Tjernvik, 1956, pp. 188-194, text-fig. 27, pl. 1, figs. 5-15; Whittard, 1955, pp. 7-10, text-fig. 2a, pl. 1, figs. 1-4, 7-8). A species doubtfully referred to this genus by Kielan (1959, pp. 58-59, pl. 1, fig. 4, text-fig. 12) is from the Upper Ordovician of Poland.

Trinodus (Whittington, 1950b; Kielan, 1959), an abundant and widespread genus in the Middle and Upper Ordovician, differs from *Geragnostus* mainly in the absence of the median tubercle and lateral furrow from the glabella and the relatively shorter axis of the pygidium. The difficulties in distinguishing between *Trinodus* and *Geragnostus* are revealed in Ross' (1958, pp. 563-564) recent discussion.

GERAGNOSTUS CLUSUS n. sp.

Plate 1, figures 1-17; Text-figure 3

Holotype. GSC 16171, almost complete enrolled specimen with exoskeleton, Pl. 1, figs. 1-6.

Description. Glabella of length (sag.) almost three-quarters that of cephalon, widest (tr.) across occipital ring, in front of this ring narrowing abruptly and then tapering slightly forward to rounded anterior lobe. Occipital ring consisting of two triangular lateral lobes joined by a shorter (sag.), narrow median band, posterior margin of which is excavated in a slight notch (Pl. 1, fig. 2). The anterior portion of the lateral occipital lobe slopes steeply back, and the posterior portion and median band

slope vertically to the straight, transverse margin. Glabella in front of occipital ring with a narrow median ridge extending forward up the slope for a short distance from the occipital furrow (Pl. 1, figs. 2, 7, 9, 12); low, faint median tubercle situated at about one-third the length; in line with this tubercle lateral margin faintly indented beside axial furrow. Cheek and preglabellar area gently convex, sloping vertically at postero-lateral margins, less steeply in front of glabella. Border narrow postero-laterally, broadening forward to a maximum width at the obtusely angulate antero-lateral margin, narrower anteriorly. Border furrow broadest antero-laterally. Posterior border narrow, convex, defined by deep border furrow, extended back by blunt, short genal spine (Pl. 1, fig. 12).

Anterior thoracic segment (Pl. 1, fig. 2; Text-fig. 3a) rectangular in outline, composed of broad axial ring and narrow (tr.) pleurae. Anterior quarter of axial ring flattened, depressed, faint median notch in margin opposite notch in posterior margin of occipital ring; remainder of ring divided, by furrows which run outward and backward, into convex median and lateral lobes. Convex pleura divided by shallow transverse depression, presumably the pleural furrow, into a larger anterior and smaller posterior portion. Second thoracic segment (Pl. 1, figs. 2, 6; Text-fig. 3b) having trilobed axial ring similar to that on first segment, in front of which is articulating furrow and short (sag. and exs.) articulating half-ring. Pleura falcate in outline, curving forward and outward, divided by a deep pleural furrow which runs out to the pointed tip.

Convex axis of pygidium divided into two rings and a rounded posterior portion. First ring furrow present laterally but absent in the median one-third of the axis; ring trapezoidal in outline because axial furrows converge back. The lateral lobe of this ring has a slight independent convexity and is separated from the narrower (tr.) median lobe by a faint furrow which runs backward and outward. Second axial ring rectangular in outline, defined posteriorly by deep, complete ring furrow, posterior median portion elevated in a tubercle which is backwardly directed. Posterior portion of axis in smaller specimens (Pl. 1, fig. 4) of same width as second ring and of length equal to that of the two rings; in larger specimens (Pl. 1, fig. 10) it is relatively longer and may be wider than the second ring. Pleural regions gently convex and sloping more steeply laterally than posteriorly. Border defined by deep border furrow, and widest postero-laterally where at the obtusely angulate margin there

is a short, backwardly-directed border spine. Convex anterior border of pleural region defined by deep furrow, anterior slope of border forming a facet.

External surface of exoskeleton bearing reticulate pattern of raised lines (Pl. 1, fig. 10).

The above description relates to the external surface of the exoskeleton, as it is preserved in specimens such as the originals of Plate 1, figures 1-11. Other specimens (Pl. 1, figs. 13-17) clearly have the exoskeleton stripped away partially or even entirely. In such specimens the axial furrows, preglabellar furrow, ring furrows of the pygidium, appear much deeper and broader, since what is preserved is a mould of the inner surface of the exoskeleton in this region. Similarly, the border furrows appear much deeper and wider because what is preserved is a mould of the external surface of the doublure. In profile view these specimens show the distal parts of the cheek, preglabellar field, and pleural regions descending vertically to the border furrow (actually to the mould of the doublure). Evidently the doublure of cephalon and pygidium extended inward horizontally beneath the borders about as far as the border furrow. When the exoskeleton was enrolled these surfaces of the doublure lay one against the other. The border of the pygidium is slightly raised adjacent to the base of the pleural spine, but the doublure adjacent to the base of this spine appears to have been flat. Thus in specimens in which only the mould of the doublure of the pygidium is preserved the border spine is difficult to detect.

Discussion. This species is extremely like the type and other species of *Geragnostus* from the early Ordovician described by Tjernvik (1956, text-fig. 27), there being no glabellar furrow in front of the occipital furrow, though the faint depression in the side of the glabella at about one-third the length may represent the extremity of such a furrow. Tjernvik does not show a genal spine in the species he described, but it is present in *G. maccoyi* (Whittard, 1955, p. 8).

I have examined the type material of *Trinodus galba* (Billings, 1865, pp. 297-298, fig. 288) from divisions M, N, P at Table Point, of *"T." fabius* (Billings, 1865, pp. 298-299, fig. 289) from 4 miles north-east of Portland Creek, and of *T. longicollis* (Raymond, 1925, pp. 12-13, pl. 1, figs. 5, 6) from the Table Head limestones at Table Point. *Geragnostus clusus* n. sp. is different from any of these species.

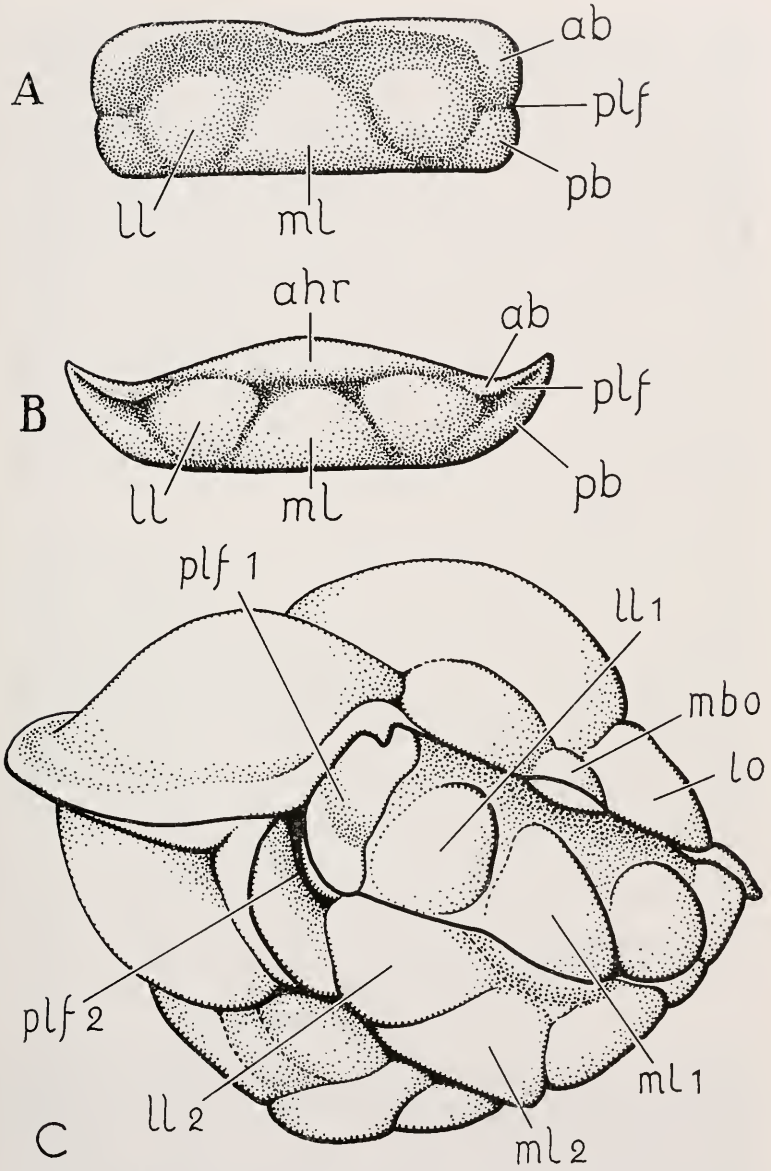

FIG. 3. *Geragnostus clusus* n. sp. A, first thoracic segment; B, second thoracic segment; *c.* x 26. C, enrolled exoskeleton, oblique posterolateral view, *c.* x 36. Compare Plate 1, figures 2, 6. Abbreviations: *ab*, anterior band of pleura; *ahr*, articulating half-ring; *ll*, lateral lobe of thoracic axis; *lo*, lateral lobe of occipital ring; *mbo*, median band of occipital ring; *ml*, median lobe of axial ring; *pb*, posterior band of pleura; *plf*, pleural furrow. 1, 2, refer to first and second segment.

The way in which the thoracic segments articulate with each other, and with the cephalon and pygidium, is shown in Text-figure 3. The straight posterior edge of the occipital ring fits against the straight anterior edge of the axial portion of the first thoracic segment, the small median notches in these two edges being opposed to each other. There is no sign of an articulating half ring on this first segment. The pleura fits beneath the raised posterior border of the cephalon immediately inside and beneath the short genal spine. An articulating half-ring is present on the second thoracic segment and on the pygidium, these rings being visible in the enrolled specimens (Pl. 1, fig. 6). The forwardly-pointing pleura of the second segment fits, when the exoskeleton is enrolled, between the pleura of the first segment and the facet of the pygidium, the pointed tip being beneath the postero-lateral corner of the cephalon. The similarity in outline of cephalon and pygidium, and the flat doublures, enables a close fit with no openings between the parts of the exoskeleton when it was enrolled.

These observations on the exoskeleton are like those of Jaekel (1909, pp. 381-385, text-figs. 1-6) on *Trinodus erraticus,* and Ross (1958, pl. 83, figs. 1-4, 14-16) has illustrated enrolled specimens of *T.? valmyensis.* Jaekel did not mention the articulating half-ring of the second thoracic segment, and though he shows (text-fig. 5) a median posterior notch in the margin of the cephalon, he shows no corresponding notch in the first thoracic segment. Jaekel and Ross regarded the posterolateral lobe of the glabella as occipital, but those here called lateral lobes of the thoracic axis as "pleural." It seems more likely to me that these lobes are part of the axial region.

Family HARPIDAE Hawle and Corda, 1847

Genus SELENOHARPES Whittington, 1950

SELENOHARPES VITILIS n. sp.

Plate 2, figures 4-8; Plate 3

Holotype. GSC 16176, almost complete cephalon with much of upper lamella of fringe preserved, upper external and internal rims broken off (Pl. 2, figs. 5-8).

Description. Cephalon oval in outline, maximum width in line with posterior border and less than length including prolongations; length (sag.) about equal to that of prolongation (exs.), height about one-third maximum width. Glabella tapers

gently forward, posterior margin of occipital ring with strong backward curvature, occipital furrow deepest distally, narrow and shallower medially; median occipital tubercle adjacent to furrow. Small, gently convex basal glabellar lobe. Convex cheek lobe slopes distally, deep posterior border furrow and convex posterior border. Eye lobe situated far forward and connected to axial furrow by prominent eye ridge. Ala of length (exs.) about one-third that of glabella, depressed below level of remainder of cheek. Steeply sloping distal part of cheek is continued by steeply sloping cheek-roll, brim gently and evenly concave, with prominent upper external rim adding to the concavity. Prolongation also concave upwards, inner part steeply sloping. Girder deep, projecting inward and downwards (Pl. 3, fig. 8), posteriorly curving around across the proximal part of the prolongation to meet the internal rim a short distance behind the posterior border. On upper lamella of fringe a smooth band lies above the girder. Most of the prolongation is part of the brim. Cheek lobe and preglabellar field (which is narrower [sag and exs.] than the cheek-roll anteriorly) bearing genal caeca (Pl. 2, fig. 8; Pl. 3, fig. 11) which originate from a point beside the axial furrow about midway between the eye ridge and anterior edge of the ala. The genal caeca continue over the cheek-roll, the smooth band above the girder, and across the brim to the external rim. The caeca are preserved as low ridges on the external surfaces of both lamellae, especially on the cheek-roll and inner part of the brim. On the prolongation the ridges are less prominent, anastomosing, and running more or less transversely. The genal ridge extends on to the cheek-roll, and in the holotype (Pl. 2, fig. 8) continues in a longitudinal direction on the brim prolongation. Between the genal caeca are minute pits, 10-12 in the width of the cheek-roll anteriorly and anterolaterally, some 30-35 in the brim in the same region. Reticulate pattern of raised ridges on the occipital ring, faint or absent on glabella in front of this ring.

A detached thorax of 16 segments and pygidium (Pl. 3, figs. 2-4, 6) has the left half of the most anterior segment preserved, and in front of this is a fragment of an axial ring and what may be part of a pleura. If so, the thorax would include at least 17 segments. Moderately convex axis tapers progressively back, axial rings slightly inflated distally, posterior margin of ring with a backwardly convex curvature. Inner part of pleurae broad (tr.), horizontal, outer part narrow, bent down so that the tip is vertical and curved back, the antero-lateral portion

broadly facetted. Pleural furrow is broad and extends out to inner margin of facet. Counting the very fragmentary segment as the first, the second to fifth are progressively wider and less acutely bevelled anterolaterally. This arrangement enables the pleurae to lie against the inner edge of the prolongation as it curves outward and backward from the posterior margin. From the sixth segment posteriorly the segments become progressively narrower (tr.) and shorter (sag. and exs.), the curve of the outer margin of the thorax corresponding with the inward and backward curvature of the internal rim of the distal part of the prolongation. If the thorax consisted of 16 or 17 segments the pygidium would lie about level with the tips of the prolongations. Pygidium broad and short, axis tapering to bluntly rounded point, pleural region curved gently downward. Pleural furrow of first segment curves outward and backward, dying out close to the margin.

The smallest cephalon (Pl. 3, figs. 7, 9, 10), of length (sag.) approximately 4 mm., has a more convex glabella with steeply sloping sides, and reticulate ridges on the external surface. A fragment of a larger cephalon (Pl. 2, fig. 4) shows the glabella to be relatively wider posteriorly.

Discussion. The above description relates to 18 well preserved cephala ranging in length (sag.) from 4 to 7.5 mm. Five additional cephala are apparently similar in all respects except for slight differences in the genal prolongation. This prolongation is relatively slightly shorter in these cephala, the distal portion much less strongly incurved, as revealed particularly by the outline of the internal rim in dorsal view. Further, the girder curves inward laterally to reach the internal rim at a point slightly in front of the mid-length. In the more abundant cephala the girder curves inward much more sharply, so that the length (exs.) of the cheek-roll prolongation is about the same as the width (tr.) of the cheek-roll laterally. Comparison between dorsal and lateral views of the holotype (Pl. 2, figs. 7, 5) and a cephalon of similar size (Pl. 3, figs. 1, 5) will illustrate these differences, which are found in cephala ranging in length (sag.) from 4 to 7.5 mm. It seems probable that the outline of the margins of the thoracic pleurae, which forms a curve convex outward, is closely similar to the curvature of the internal rim of the prolongation. If this is correct, then the differences in shape of the two types of prolongations may reflect differences in shape of the thorax, i.e. the thorax of the less common type of cephalon could have had relatively wider (tr.) posterior thoracic segments.

Genal ridge and genal caeca in harpids have been defined and discussed by Whittington (1950a, pp. 16-18, text-figs. 10, 11; 1950c, pl. 1). Caeca have been more commonly observed on Cambrian trilobites, and descriptions and discussion of such impressions have recently been given by Öpik (1961).

Selenoharpes vitilis is more like the Lower Ordovician species *S. excavatus* and the Middle Ordovician species *S. concavus* (Whittington, 1950c) from Sweden than the type species *S. youngi* from the Middle Ordovician of Scotland (Whittington, 1950a, pp. 10, 30-32, pl. 3, figs. 2-7, text-fig. 6). This is because the brim is concave on the dorsal side, and the fringe displays the radiating genal caeca, between which the pits are small, there being no conspicuously larger pits adjacent to the girder or adjacent to the external rim. The genal caeca are not as strongly developed as in *S. excavatus,* and the preglabellar field is shorter (sag.) than the cheek-roll. The differences between the four species mentioned are slight, though their occurrence is over a long period of time and in geographically widely separated regions.

Raymond (1925, p. 16, pl. 1, figs. 10, 11) described *Selenoharpes fragilis* from a boulder in the Cow Head Group from Stearing Island (Text-fig. 1; Kindle and Whittington, 1958, p. 332). Since it was associated with a species of *Pseudomera* it probably came from the highest conglomerate bed on the southeast side of Stearing Island. The type material (Pl. 1, figs. 18-20; Pl. 2, figs. 1-3) is poorly preserved, but seems to differ from *S. vitilis* in that the cheek-roll slopes gently anteriorly and is much narrower laterally, and the brim slopes outward and downward from the girder, becoming flat peripherally and gently concave laterally. In dorsal view the cephala differ in outline, and in profile the other differences noted are most evident.

Now that species of *Selenoharpes* are known with the cephalon suboval in outline, the radiating caeca extending across the fringe to the external rim, the pits between the caeca small, and the thorax in one species of at least 17 segments, the pygidium having the ribs curving backward distally, it is difficult to maintain the differences between species referred to this genus and to those placed in *Aristoharpes* (Whittington, 1950a, pp. 11-12, 43-48, pl. 6, figs. 4-11; pl. 7, figs. 1-4; text-fig. 7). It seems best to suggest therefore, that *Aristoharpes* should be regarded as a synonym of *Selenoharpes.*

Family REMOPLEURIDIDAE Hawle and Corda, 1847

Genus REMOPLEURIDES Portlock, 1843

REMOPLEURIDES LIGULUS n. sp.

Plate 4, figures 1-10

Holotype. GSC 16145, incomplete cephalon of length (sag.) approximately 5 mm.

Description. The cephalon shows the characters diagnostic of the genus (Whittington, 1959, pp. 391-392), and is distinguished by the strong longitudinal convexity of the glabella, length (sag.) of the tongue, and the long genal spine, the base of which is opposite the occipital ring. External surface of the glabella and the cheek inside the border is tuberculate, and on the glabella lateral furrows 1p and 2p are visible (Pl. 4, figs. 2, 6) as curved, smooth bands similar to those of other species (Whittington, 1959, pl. 1, figs. 5, 6, etc.). Lateral furrow 3p is not visible. In ventral view (Pl. 4, fig. 3) the anterior branches of the suture bounding the tongue are seen to run in a curve strongly convex forward. The median suture bisects a sharp projection which is situated close to the posterior margin of the doublure. The sharp flexure which forms the projection is characteristic of the genus (Whittington, 1959, p. 393), as is the pit in the doublure situated immediately beneath the anterolateral corner of the tongue. Lateral cephalic border and doublure traversed by strong raised lines. External surface of eye lobe bearing many small facets (Pl. 4, fig. 10).

Discussion. Billings (1865, p. 293, fig. 283) described the species *Remopleurides panderi* from the Table Head Series. The types of this species were not seen in the Geological Survey of Canada collections, but material collected by Kindle and Whittington shows that it is quite unlike the present species.

Family PROETIDAE Salter, 1864

Subfamily PROETIDELLINAE Hupé, 1953

PHASEOLOPS n. gen.

Type species. Phaseolops sepositus n. gen., n. sp.

Diagnosis. Glabella tapering forward, three pairs of lateral glabellar furrows. Broad, convex preglabellar field, lateral cephalic border flattened, anterior border convex, long librigenal spine. Large eye lobe situated close to axial and posterior border

furrows, anterior branches of suture widely divergent. Rostral plate triangular. Hypostome unknown. Ten thoracic segments, pleural tips pointed. Pygidium with three axial rings and three bluntly-pointed pleurae, faint anterior band of fourth pleura.

Phaseolops sepositus n. sp.

Plate 4, figures 11-13; Plate 5, figures 1-6

Holotype. GSC 16148, incomplete exoskeleton (Pl. 5, figs. 1-3).

Description. Largest exoskeletons about 6 mm. in length (sag.). Cephalon crescentic in outline, length (sag.) about half that of maximum width which is at base of librigenal spines. Glabella moderately convex, anterior lobe descending steeply to preglabellar furrow; maximum width across occipital ring and basal glabellar lobes; in front of here glabella tapers forward slightly to about the level of lateral glabellar furrow 2p; in front of here it tapers less strongly toward the rounded anterior lobe. Occipital ring longest (sag.) medially, posterior margin projecting convexly behind adjacent borders, small median tubercle on this margin. Occipital furrow bow-shaped, curving forward to midline, narrow and deep. In front of occipital furrow glabella rises steeply so that postero-medially it stands higher than ring. Three pairs of lateral glabellar furrows, 1p straight, broad, deepest medially, directed diagonally inward and backward; lateral glabellar lobe 1p of gentle independent convexity and subtrapezoidal outline. Lateral glabellar furrow 2p directed inward and only very slightly backward, deepest proximally, lateral glabellar furrow 3p short, much shallower than 2p, lateral lobe 3p with faint independent convexity. Axial and preglabellar furrows shallow, continuous, no anterior pit. Cheeks and broad (sag. and exs.) preglabellar field forming a continuous structure, distally sloping steeply outward to the broad, shallow lateral and anterior border furrows; lateral border almost flat, anterior border convex, most strongly so medially. Posterior border of similar width (exs.), convex, proximal portion transverse, then it is flexed to extend outward and backward, and before reaching the base of the librigenal spine curves to run outward. Librigenal spine broad-based, long and tapering to a sharp point, proximal portion with raised borders and a central depression, spine extends back to opposite about the eighth thoracic segment. Bean-shaped eye lobe (Pl. 4, figs. 12, 13) situated immediately adjacent to axial furrow; palpebral lobe includes only the inner slope of the eye lobe, no rim or furrow.

Most of lobe occupied by eye surface which is covered by minute facets arranged in diagonal lines and bounded on the outer side by a moderately deep furrow. Anterior branch of suture runs outward at about 45° to sagittal line down the slope of the cheek almost to the inner edge of the border furrow; here it turns abruptly and runs diagonally inward and forward across the border furrow and across the anterior border, eventually reaching the outer edge of this border at a point that is close to the midline and within the projected line of the axial furrow. Behind eye lobe posterior border furrow is widest (exs.), posterior branch of suture runs diagonally across this furrow to reach the inner margin of the posterior border immediately outside where this border is flexed back; in crossing the border furrow the posterior branch of the suture lies on a sutural ridge. Suture continues diagonally outward and backward across posterior border to reach outer margin a short distance inside base of librigenal spine. Free cheek adjacent to outwardly-directed portion of the anterior branch of the suture markedly depressed below the level of the fixed cheek in front of this suture: thus the outwardly directed portion of the anterior branch runs along a flexure marking a change in slope in the cheek rather than a sutural ridge. Free cheek adjacent to eye lobe shows two bean-shaped, slightly inflated areas (Pl. 4, fig. 13), one situated adjacent to the anterolateral margin of the eye surface, the smaller inflated area adjacent to the posterolateral margin of the eye surface. Lateral and anterior doublure of cephalon of width slightly greater than borders, convex ventrally, in front of glabella crossed by connective sutures that run inward and backward to meet at the inner margin of the doublure (Pl. 4, fig. 11). A small triangular rostral plate is thus isolated. Rostral suture must run along outer margin of anterior border; and width (tr.) of anteror margin of rostral plate is the same as the distance between the points at which the anterior branches of the suture are observed to reach the margin of the anterior border. Hypostome not known. External surface of cephalon (Pl. 4, fig. 13), except in furrows, is extremely finely granulate. Scattered tubercles on cheeks and preglabellar field inside border furrows and on posterior border: slightly larger than other tubercles is that situated on the fixed cheek at the corner where the anterior branch of the suture turns forward and inward, and that situated on the posterior border immediately inside where it is crossed by the posterior branch

of the suture. Fine terrace lines on borders of librigenal spine and broader and deeper lines subparallel to the margin of the doublure.

Thorax of 10 segments, moderately convex axis tapering backward. Axial rings shaped like occipital ring, but backward curvature of posterior margin less, articulating half ring reaching to articulating furrow of segment in front. In most specimens median portions of axial rings are broken, but since there is a median tubercle on the occipital ring and on axial rings of the pygidium, it may be that some of these rings also bore a median tubercle. Inner part of pleura of anterior thoracic segment extends out horizontally to same distance as transverse inner portion of posterior cephalic border; outer part of pleurae flexed down, facetted anterolaterally and drawn out into a long point, the point terminating a short distance inside the base of the librigenal spine. In successive pleurae of the thorax the horizontal inner portion becomes narrower (tr.), the outer portion relatively wider (tr.) and flexed down less strongly at the fulcrum; outer parts of pleurae pointed and bearing a short spine, the points directed in successive pleurae more strongly backward so that in the tenth pleura the point is directed posteriorly. Broad and moderately deep pleural furrow runs out across fulcrum and dies out on pointed distal part of pleurae. Pygidium subsemicircular in outline, convex axis extending about two-thirds of length, termination rounded and steeply sloping. Three axial rings outlined by shallow ring furrows, each with prominent median tubercle, short (sag.) terminal portion. Pleural regions gently sloping outward and downward, subdivided by three curving pleural furrows and two curving interpleural furrows; distal part of each of these three pleurae bluntly pointed, the point of the third pair short. Between the third pleurae, outlined by faint third interpleural furrows, is a backwardly-sloping region behind the axis, at the edge of which is the faint anterior band of the fourth pleura. External surface of thorax and pygidium apparently smooth.

Discussion. The smallest cephalon (Pl. 5, fig. 6) is 0.7 mm. in length (sag.) and is articulated with 5 thoracic segments. It is not well-preserved, and appears little different from larger specimens.

The oldest supposed proetid is *Paryfenus lovisae* (Hadding, 1913, p. 79, pl. 8, fig. 21), an incomplete cranidium from the Upper Llandeilo of Sweden. This tiny cranidium is in my opinion doubtfully a proetid, and *Phaseolops* is little like it.

From younger rocks (Lower Caradoc of Britain) comes *Proetidella fearnsidesi* (Bancroft, 1949, pp. 303-305, pl. 10, fig. 23), an almost complete exoskeleton of distinctly proetid appearance, which has been taken as the type genus of the subfamily Proetidellinae by Hupé (1953). Like *Phaseolops* the cephalon is crescentic in outline, the glabella tapering forward (with, however, apparently only faint lateral furrows 1p), the eye lobe large, close to the axial furrow and posterior border furrow, the anterior branches of the suture diverging strongly forward, the preglabellar field broad (sag.), the thorax of 10 segments, the pygidium semicircular in outline (but relatively larger, showing six axial rings and five pairs of pleurae). The rostral plate of *Proetidella* is not known, and that of *Phaseolops* is unusual for proetids in being subtriangular in outline rather than a wide (tr.) short (sag.) rectangle. Among Upper Ordovician proetids *Phaseolops* bears some resemblance to *Warburgaspis modestus* (see Warburg, 1925, pp. 167-170, pl. 5, figs. 15, 16, 18) in the general outline of the exoskeleton including cephalon, position of the eye lobes, divergent anterior branches of the suture, shape of the thoracic segments and pygidium. These resemblances lead me to consider *Phaseolops* as a proetid, and if this is accepted it is the oldest known member of the family. If the genus is referred to the subfamily Proetidellinae, the diagnosis given by Richter, Richter and Struve (*in* Moore, 1959, p. 0 395) needs modification to include pygidia having three axial rings and three pairs of pleural furrows.

Family ISOCOLIDAE Angelin, 1854

Discussion. Weir (1959, pp. 375-377, pl. 62, figs. 11-15) has described new material of *Thomondia* Harper, 1942, and shown that the type and only known species is an isocolid. Weir suggests that my diagnosis of the family (1956, p. 1194) should be emended to remove the statement that the greatest width of the glabella is at, or in front of, the midlength. If, however, one considers the glabella to include the occipital ring then the maximum width of the glabella in *Thomondia* is about at the midlength. The diagnosis needs emendation in that eye facets are present in the species described below, the anterior cephalic doublure is preserved and may be crossed by either a levisellid or asaphid suture.

Weir's material came from a mudstone, and this is an unusual occurrence of an abundant isocolid in a clastic facies rather than

in reef limestone (Whittington, 1956, p. 1193). If *Pradesia martyi* is an isocolid (Whittington, 1956, p. 1198) it is another species coming from a clastic facies.

Genus Isocolus Angelin, 1854

Isocolus dysdercus n. sp.

Plate 5, figures 7-10; Plate 6, figures 1-9, 16

Holotype. GSC 16153, entire exoskeleton (Pl. 6, figs. 1-4).

Description. Exoskeleton of holotype 3.75 mm. in length (sag.), other entire exoskeletons smaller, the smallest 2.3 mm. in length. Cephalon quite strongly convex, length (sag.) about two-thirds of maximum width, which is in line with the occipital ring. Glabella elongate-oval in outline, gently convex except distally where it descends steeply to the bounding furrows. Occipital ring longest (sag.) in the mid-line, posterior margin curving strongly back, anterior margin defined by occipital furrow which curves less strongly forward. Occipital furrow narrow, deep behind the mid-part of the basal lateral glabellar lobe, shallowing adjacent to the axial furrow. Two pairs of short, deep, transversely-directed lateral glabellar furrows, furrow 1p extremely shallow adjacent to axial furrow, deepening inward and broadening, furrow 2p commencing a short distance inside the axial furrow, narrower and less deep than 1p. Lateral glabellar lobes with slight independent convexity, lope 1p slightly shorter (exs.) than lobe 2p; lateral furrow 2p situated at mid-length of glabella, maximum width of glabella at this point or slightly in advance of it. Cheek curves outward and downward from axial furrow, posterolateral portion vertical, anterolateral portion steeply sloping where it merges with the moderately wide (sag. and exs.) preglabellar field; shallow lateral and anterior border furrows, narrow, gently convex, lateral and anterior borders. These borders join a short distance outside the point where the suture crosses the anterior border, and this junction is obliquely angulate and slightly inflated (Pl. 6, figs. 2, 4). Posterior border convex, running transversely outward from axial furrow, then curving backward and broadening as it merges with base of librigenal spine; this spine tapers back and is extended so that the tip is opposite the third or fourth thoracic segment. Posterior border furrow deep, transverse, dying out near the base of the inner margin of the librigenal spine; lateral border furrow and border continue

along outer margin of librigenal spine. Doublure of cheeks (Pl. 5, figs. 7, 9) broad, curled up beneath border, and inside border furrow lying close against dorsal exoskeleton; inner margin of doublure lies beneath preglabellar furrow, anterolaterally and laterally width of doublure is similar, posterolaterally it broadens where it extends beneath the base of the librigenal spine. In the midline a low ridge (in the ventral surface, groove in the dorsal surface; Pl. 5, figs. 7, 8) crosses the doublure. Eye lobe (Pl. 5, fig. 10) suboval in outline, situated adjacent to the axial furrow and a short distance in front of lateral glabellar furrow 2p; convex, outlined by a furrow which is best developed along the anterior, outer and posterior margins. The inner, higher part of the eye lobe, adjacent to the axial furrow, is the most convex, and the palpebral lobe includes the inward slope of this portion. On the steep, outer slope of this portion of the eye lobe are some 20-30 irregularly arranged facets of the eye surface. Outside the facetted area the surface of the eye lobe is less convex, and in many specimens may be seen to be divided by a low ridge which runs downward and backward from the visual surface to the furrow at the margin, this ridge being flanked by a larger anterior, and a smaller posterior, flattened, elliptical area. Anterior branch of facial suture runs straight forward down the slope of the cheek, curving inward and running on a sutural ridge across the border furrow and onto the outer margin of the anterior border. Cranidia (Pl. 6, figs. 5, 6) suggest that the anterior branches of this suture meet in a smooth curve along the margin of the anterior border. Connective sutures do not seem to be present (Pl. 5, figs. 7, 8, 10), though the appearance of some specimens (Pl. 6, fig. 16) suggest that the median ridge in the doublure may be traversed by a median suture or by connective sutures which are very close together. The facial suture may therefore be levisellid or asaphid in type. Posterior branch of suture (Pl. 6, figs. 5, 6, 8) runs in curve outward and back across the cheek to the distal extremity of the posterior border furrow, from whence it runs backward to reach the margin of the border inside the base of the librigenal spine. On external surface of the fixed cheek a conspicuous ridge runs in a straight line backward and slightly outward from the eye lobe to about the mid-point of the posterior border furrow, where it dies out. Anastomosing raised lines are strongly developed on the glabella in front of lateral lobes 2p and run in curves subparallel to the axial and preglabellar furrows.

Similar terrace lines may traverse the fixed cheek in front of the eye lobe and the preglabellar field. Hypostome unknown.

Thorax of six segments, convex axis tapering back, axial rings backwardly curving, similar in shape to occipital ring, gently inflated at anterolateral corner. Inner part of pleura extends out horizontally, outer part flexed down steeply, facetted and drawn out into a backwardly directed point. Pleural furrow broad and deep, especially adjacent to the fulcrum, running closer to anterior than posterior margin of pleura so that anterior band is narrowest (exs.) and convex. Pygidium semicircular in outline, tapering axis reaching close to posterior margin and divided by three shallow ring furrows into three rings and a small terminal portion. Pleural regions adjacent to axis horizontal, distal portions and area behind axis steeply sloping, narrow, ill-defined gently convex border. Three pairs of pleural furrows curve outward and backward, successively diminishing in depth posteriorly; first and second interpleural furrows extremely faint. Doublure extends inward in both thorax and pygidium to fulcrum and tip of axis. External surface minutely granular.

Discussion. The smallest exoskeletons of *Isocolus dysdercus* differ from larger ones mainly in that the straight-sided, posterior part of the glabella expands forward to a maximum width which lies between the eye lobes; in larger specimens the preoccipital portion is relatively wider, giving the suboval outline.

Isocolus dysdercus differs from the type species *I. sjögreni* (Whittington, 1956, pp. 1194-1195, pl. 129, figs. 1-11, text-fig. 1) in that the preglabellar field is longer (sag. and exs.) and the cheek broader (tr.), there being a narrow border anteriorly; the inflated distal part of the axial ring is less prominent, and on the pygidium there is a faintly defined border as well as the first two interpleural furrows. The nature of the cephalic doublure was not well displayed by the material of *I. sjögreni*, but the present specimens show that the outer part of this doublure was convex ventrally, the inner part curved so that it lay close beneath the dorsal exoskeleton. The cranidia show that the facial sutures were functional and that eye facets are present, but it remains uncertain whether or not the facial suture is levisellid in type. Enrolled specimens are present in the Newfoundland material, the margin of the pygidial border fitting closely against the doublure beneath the cephalic borders.

Though the two known species of *Isocolus* are alike in both

occurrence and morphology, they are widely separated in age, the range of the genus and the family now being from earliest Middle Ordovician to Upper Ordovician. The only older supposed isocolid is *Pradesia martyi* from the Lower Ordovician of southern France. Among late Cambrian trilobites, species of *Theodenisia* (Rasetti, 1954, figs. 3 a-e) show some resemblance to *Isocolus,* and in one species of *Theodenisia* an asaphid-type suture is known.

Erben (1961), in a discussion of blinding and extinction in certain Proetidae, has pointed out (p. 95) that the isocolid eye lobe is of the "cryptophthalmus" type. This type is based on the eye lobe of *Cryphops cryptophthalmus* (R. and E. Richter, 1926, pp. 10, 160, pl. 9, fig. 56f; R. Richter, E. Richter and Struve *in* Moore, 1959, p. 0 462, figs. 362, 2b; 365, 1 a-e), an Upper Devonian phacopid. In this species the dome-like lobe is crossed by a suture running in a curve that is concave outward, not convex outward as in most trilobites, the eye surface is elliptical, and the palpebral lobe not raised above the remainder of the eye lobe. Having facets, the eye lobe of *I. dysdercus* is quite like that of *C. cryptophthalmus.* Whether this resemblance means, as Erben suggests, that eye reduction in isocolids occurred in the "cryptophthalmus-mode," is problematical. Erben further suggests that isocolids were adapted to life in dark submarine cavities. In the present deposit, *I. dysdercus* occurs alongside species with well-developed eye facets, so there is no evidence for Erben's suggestion.

Family ISOCOLIDAE ?

Genus IDIORHAPHA Whittington, 1953

IDIORHAPHA SOLITARIA (Billings, 1865)

Plate 35, figures 1, 3, 4, 6, 8

Whittington, 1953b, pp. 675-676, pl. 69, figs. 11-15.

Discussion. A single incomplete cephalon, poorly preserved, appears indistinguishable from the type material, which came from a boulder in Quebec. The glabella, eye-lobe and course of sutures (the posterior branch is visible on the left side) are exactly as in the type. The anterolateral borders are broken, so that this flattened, broader border cannot be seen. The narrow (sag. and exs.) anterior border is well-preserved, and shows how the exoskeleton curls under to form the narrow, flat doublure. The anterior branch of the suture curves inward over

the border and across the doublure, reaching the inner margin at a point about in line with the projection of the axial furrow (Pl. 35, figs. 6, 8). The anterior edge of the border and outer part of the doublure bear raised lines, the inner part of the doublure being smooth, the inner edge raised. No rostral suture is apparent traversing the border or doublure, and this suture may form the inner edge of the preserved part of the doublure.

Possible relationships of *Idiorhapha* were discussed previously, and the only new suggestion I have is that this genus might belong in the Isocolidae (see above). The large, facetted eye lobe is unlike that of other isocolids, but the glabella, course of the dorsal sutures, broad anterolateral border and long librigenal spine are quite like *Isocolus*. The narrowness of the doublure anteriorly and absence of a median suture are unlike *Isocolus*.

Family DIMEROPYGIDAE Hupé, 1953

Genus ISCHYROTOMA Raymond, 1925

Type species. Ischyrotoma twenhofeli.
Subjective synonym. Dimeropygiella Ross, 1951.

ISCHYROTOMA TWENHOFELI Raymond, 1925

Plate 7

Raymond, 1925, pp. 54-55, pl. 3, figs. 1, 2.

Holotype. YPM 13055, internal mould of incomplete cephalon (Pl. 7, figs. 1, 2, 4).

Description. Convex cephalon of length (sag.) about equal to maximum height, lateral part of cheek sloping vertically, the border curving forward and upward to the midline, these borders joining medially at an angle of about 90° (Pl. 7, fig. 13). Glabella convex, parallel-sided, the rounded frontal lobe projecting over the anterior border; deep, broad occipital furrow is straight, occipital ring projects back behind adjacent part of posterior borders. Lateral glabellar furrows 1p and 2p indicated by faint, smooth depressions that extend up the steep side of the glabella for a short distance and are best seen on the internal mould (Pl. 7, fig. 8); 1p situated in line with a point a short distance behind the eye lobe, 2p in line with the anterior margin of the eye lobe. Axial and preglabellar furrows broad and deep, no anterior pit. Convex cheek subsemicircular in outline, broad, convex lateral and anterior border which is separated from the rest of the cheek by a broad, deep border furrow; posterior border and border furrow narrower (exs.).

No preglabellar field separates the border from the preglabellar furrow medially; laterally a gradually widening (exs.) portion of the cheek separates the anterior border and preglabellar furrow. Eye lobe situated opposite about midlength of glabella, close to axial furrow and on the highest part of cheek; subdivided by suture into a narrow (tr.), steeply-sloping palpebral lobe with a narrow rim, and convex eye surface bearing small facets. Anterior branch of suture runs forward and inward, in a curve that is sharper than that of the axial and preglabellar furrows, across the border furrow and the outer face of the border to form, with the opposing suture and the rostral suture, a straight line (Pl. 7, fig. 13). Connective sutures commence on outer face of border and are sub-parallel, as they traverse the ventral face of the border they converge, and then, as they continue across the doublure (which extends inward and upward to a point beneath the outer margin of the border furrow), curve upward and outward to the inner margin (Pl. 7, figs. 11, 12). Thus the rostral plate is narrowest on the ventral side of the border and widens inward and upward toward the inner edge of the doublure; it is not flat but strongly curved in the longitudinal direction. Posterior branch of suture runs backward and outward in an almost straight line to cross the posterior border furrow and posterior border close to the extremity of the latter; outside the suture the junction between the posterior and lateral borders forms an oblique angle which does not bear a genal spine, only a tubercle (Pl. 7, figs. 5, 7). External surface, except in furrows and along lateral and anterior cephalic borders, bearing large, close-spaced tubercles, between which are smaller tubercles. On outer surface of cephalic border are scattered smaller tubercles, on the ventral surface terrace lines running subparallel to the margin, doublure of borders smooth.

Thorax of eight segments, convex axis tapering only slightly posteriorly, axial rings inflated at anterolateral corner, articulating furrow deep, articulating half-ring long. Inner part of pleura horizontal, width (tr.) less than that of axial ring, outer part of pleurae bent down to slope steeply and broadly facetted. Well-defined pleural furrow runs diagonally across inner part of pleura, over fulcrum, and ends against inner margin of broad facet. Anterior band of inner part of pleurae narrow (exs.) with large tubercle at fulcrum; posterior band broader (exs.), more strongly convex and inflated adjacent to axial furrow, distally it extends onto outer part of pleura and ends against facet.

Pygidium with triangular axis showing five axial rings decreasingly convex posteriorly and marked off by shallower ring furrows; outer part of axial ring of first three rings inflated. Inner part of pleural regions narrow (tr.), horizontal, subdivided by five interpleural furrows, first pleura showing diagonal pleural furrow and both bands, succeeding pleurae showing only the convex posterior band. Outer parts of pleurae steeply sloping, behind axis a faint sixth pair of pleural ribs. In the enrolled specimen (Pl. 7, figs. 10, 11) outer pleural regions fit closely beneath doublure of cephalon, and inverted "V"-shaped outline of anterior margin of cephalon corresponds with margins of pygidium. External surface of both axial rings and pleural bands bearing closely spaced tubercles, those on the swollen outer part of the rings and the inner part of the posterior pleural band being the most prominent.

Discussion. The cephalon and pygidium of *Ischyrotoma* are extremely like those of the type species of *Dimeropygiella* (Ross, 1951, pp. 123-125, pl. 35, figs. 18, 22-28) and of the two older species described by Hintze (1953, pp. 153-156, pl. 19, figs. 1-10). The preglabellar field is absent medially in both *Ischyrotoma* and *D. caudanodosa,* but is present in the species described by Hintze, being quite long (sag.) in *D. blanda.* A short, smooth zone adjacent to the axial furrow, representing lateral glabellar furrow 1p, is clearly visible in Hintze's illustrations (1953, pl. 19, figs. 1c, 6b). At the genal angle in *Dimeropygiella* there is a tubercle, as in *I. twenhofeli.* The many characters common to these species suggest that they may belong within one genus, for which the oldest available name is *Ischyrotoma.*

As Hintze (1953, p. 154) remarked, Ross' original diagnosis of *Dimeropygiella* needs some modification (cf. Whittington, *in* Moore, 1959, pp. 0 412-413) — the preglabellar field may or may not be present medially, the librigenal spine is represented only by a tubercle, and the pygidium consists of 5 or 6 segments. It may now be added that the thorax consists of 8 segments, the same number as in *Dimeropyge* (Whittington and Evitt, 1954, pp. 35-46, pls. 2; 3, figs. 1-30; 22; 23; text-figs. 5-10). This latter genus may now be distinguished from *Ischyrotoma* (=*Dimeropygiella*) by always exhibiting the preglabellar field, the long librigenal spines, and the pygidium consisting of four segments, the pleurae of which exhibit the anterior band. The short spines on the external surface, and particularly the groups at the termination of each thoracic and pygidial pleurae, may

also characterize *Dimeropyge*. The rostral plate of *Ischyrotoma* is evidently like that of *Dimeropyge* (Whittington and Evitt, 1954, text-fig. 8).

Ischyrophyma n. gen.

Type species. Ischyrophyma tuberculata n. sp.

Diagnosis. Deep, convex cephalon. Glabella subparallel-sided, projecting in front of anterior border, deep lateral furrow 1p defining small basal lobe, furrow 2p short, faint. No preglabellar field, projection at junction of straight anterior and curving lateral border. Large, prominent eye lobe close to glabella and opposite mid-length. Narrow rostral plate. Hypostome unknown. Thoracic segments with broad posterior pleural band, shallow pleural furrow, outer part bent down. Pygidium unknown.

Ischyrophyma tuberculata n. sp.

Plate 8, figures 1-10

Holotype. GSC 16166, incomplete cephalon with six thoracic segments, some exoskeleton adhering (Pl. 8, figs. 1-3, 5).

Description. Cephalon strongly convex, height a little less than maximum width. Glabella subparallel-sided, rounded in front, convex and projecting well in front of the anterior border; occipital ring not well preserved, lenticular in outline, defined by occipital furrow that curves convexly forward and is deepest distally, outer part of occipital ring narrow (exs.) and convex. Lateral glabellar furrow 1p short, deep, diagonally directed, dying out inwards but connected by extremely shallow depression to the occipital furrow; lateral glabellar lobe 1p subtriangular in outline, convex. Extremely small, smooth area adjacent to axial furrow and opposite mid-point of eye lobe (Pl. 8, figs. 3, 7) may represent lateral furrow 2p. Broad, deep axial furrow runs straight forward and forms a continuous curve with preglabellar furrow. Cheek convex, steeply sloping, the median part overhanging the border; broad, deep lateral border furrow and narrower, sharply convex lateral border, latter meets the straight anterior border at an oblique angle, there being a projection at this angle (Pl. 8, fig. 4). Large, prominent eye lobe situated on highest part of cheek opposite about mid-length of glabella; most of eye lobe occupied by eye surface (Pl. 8, fig. 10) which is covered by minute convex facets arranged in diagonal lines, palpebral portion of lobe being only the steep

inner side. Anterior branch of suture curves inward and forward across cheek on to angle between anterior and lateral borders; suture then continues along outer edge of anterior border to form a straight line with the rostral suture. The doublure is curled under the lateral and anterior borders so that the inner edge lies close beneath the border and preglabellar furrow. The connective sutures isolate a narrow, ventrally-projecting rostral plate, which is curved in a longitudinal direction through about 180° and widens (tr.) posteriorly (Pl. 8, figs. 4-6). Posterior border of cheek runs outward, increasing slightly in width (exs.), to meet the lateral border at an oblique angle; posterior border furrow of equal width and depth to the lateral border furrow. Small, thorn-like librigenal spine arises from posterior edge at junction of borders (Pl. 8, fig. 7). Posterior branch of suture runs back and slightly outward to cross posterior border well inside base of librigenal spine. External surface, except in furrows, bearing large, closely and irregularly-spaced tubercles, these tubercles forming a row along the antero-lateral border.

Hypostome unknown.

Thorax not well preserved, the axial rings being broken off to expose the long (sag.), convex, articulating half-rings, only the narrow (exs.), convex distal part of the axial rings being preserved. Inner part of pleurae horizontal, outer part bent down steeply and facetted. There appears to be a convex posterior band which extends distally onto the outer part of the pleurae, in front of this band a shallow, ill-defined pleural furrow. Flanges narrow (exs.).

Discussion. Jaanusson (1956) redescribed *Celmus* from the Lower Ordovician of Sweden, and discussed its possible relationships with *Dimeropyge*, *Hystricurus*, and other genera, concluding that it should be placed in a new family Celmidae. *Ischyrophyma tuberculata* resembles *Celmus granulatus* in the general form and convexity of the cephalon, presence of the basal glabellar lobe, position of the eye lobe, and course of the cephalic sutures; it differs in the relatively smaller size of lateral glabellar lobe 1p, the faintness of furrow 2p, and absence of furrow 3p. Clearly the cephalon of *Ischyrophyma* is also like that of *Ischyrotoma*, the latter not displaying the basal glabellar lobe and having the snout-like projection of the anterior border. The cephala of these three genera are suggestive of relationship, but the pygidium of *Celmus* is quite unlike that of *Ischyrotoma*

and other dimeropygids. Because of the lack of knowledge of the thorax and pygidium of *Ischyrophyma* it seems best to regard it tentatively as a dimeropygid.

? Ischyrophyma sp. ind.
Plate 6, figures 13-15

Description. This cephalon has a dimeropygid appearance but differs from that of *I. tuberculata* in the less tumid glabella, and the less convex cheeks which slope vertically laterally but do not overhang the border. The latter is broad and convex, the lateral border furrow shallow, the doublure curled under to reach the lateral furrow and sloping vertically. Posterior branch of the suture directed much more strongly outward than in *I. tuberculata,* curving distally to cross the border at the genal angle.

Cephalon gen. ind.
Plate 6, figures 10-12

Description. Glabella in front of occipital furrow tapering slightly, rounded anteriorly, strongly convex, the anterior part bulging forward and overhanging the preglabellar furrow. Lateral glabellar furrow 1p broad and moderately deep, running directly inward from the axial furrow, then turning to run backward and inward, dying out before reaching the occipital furrow. Lateral glabellar lobe 1p with slight independent convexity. Lateral glabellar furrow 2p situated opposite anterior end of eye lobe, short and shallow. Cheek convex, anterolateral part overhanging border furrow, eye lobe situated so that midpoint is opposite anterior part of lateral lobe 2p. Anterior branch of suture runs forward and inward from eye lobe, posterior branch runs straight backward and outward. External surface of glabella and cheek, except in furrows, covered with low, close-spaced tubercles.

In the shape and lobation of the glabella (except that lateral furrow 1p is wider distally) and fixed cheeks, including position of eye lobe, this cephalon resembles that described from older rocks by Tjernvik (1956, p. 265, pl. 10, figs. 20, 21) as possibly a species of *Glaphurina.* A somewhat similar cranidium has also been recorded from older rocks in western Newfoundland (Kindle and Whittington, 1958, p. 324). However, a closer resemblance is with *Ischyrophyma tuberculata,* and this cephalon

is considered much more likely to be a dimeropygid. The glabella is different from that of ? *Ischyrophyma* sp. ind.

Family GLAPHURIDAE Hupé, 1953

Genus GLAPHURUS Raymond, 1905

GLAPHURUS DIVISUS n. sp.

Plate 8, figures 11-14; Plate 9, figures 1-6, 8

Holotype. GSC 16183, an almost complete cephalon of length (sag.) 2.8 mm. (Pl. 9, figs. 1, 2, 5).

Description. Cephalon subsemicircular in outline, maximum height about half width (tr.), maximum width of glabella less than half that of cephalon. Glabella suboval in outline, maximum width at about mid-length and some two-thirds the length (sag.). Occipital ring longest (sag.) medially, narrowing rapidly distally, posterior margin a curve convex backward; occipital furrow deep, narrow and transverse, slightly deeper distally. Glabella in front of occipital ring more strongly convex, maximum height at about midlength, sloping steeply back to occipital furrow and vertically to preglabellar furrow. Lateral glabellar lobes 1p and 2p fused to form a long, narrow lateral lobe which is gently convex. On inner side is a short, deep longitudinal furrow (1p) which commences at about the maximum width of the glabella and extends back a short distance; lateral glabellar furrow 2p a deep, subcircular pit connected, by a furrow which becomes shallower outward, to the axial furrow. Cheek convex, curved downward through about 90° so that distal part is vertical, cheeks united in front of glabella by broad (sag. and exs.), gently convex, steeply sloping preglabellar field. A shallow border furrow defines a narrow, convex anterior and lateral border; in anterior view the border has an upward curvature towards the midline. Posterior border convex, narrowest (exs.) adjacent to the axial furrow, broadening outward to the genal angle, slim librigenal spine curves backward from the broadest part of the border. Large eye lobe (Pl. 8, figs. 12, 13) situated on the upper slope of the cheek, opposite the anterior glabellar lobe; eye lobe divided into a larger, inner portion and a smaller outer portion which projects from the steep outer slope of the lobe.

The fixed cheek between the inner, anterior edge of the eye lobe and the axial furrow is crossed transversely by a shallow, smooth depression which may indicate the general position of the

eye ridge. The suture appears to traverse the eye lobe along the boundary between the two portions; anterior branch curving downward and forward across the cheek and on to the border, where it curves inward and runs along the outer slope of the border to join the other suture in a smooth curve (Pl. 9, fig. 6). Posterior branch of suture curves outward and backward from the eye lobe to cross the border immediately inside the base of the librigenal spine. Doublure of cephalon apparently of similar width to the border and rolled underneath; the anterior portion of this doublure does not seem to be crossed by any connective or median suture (Pl. 8, fig. 14). External surface bearing close-spaced tubercles and short spines which are broken off at the base and appear as larger tubercles. Some of these short spines are symmetrically arranged — three pairs on the glabella in front of the occipital ring, the posterior and median pair approximately opposite the posterior and anterior ends of the longitudinal glabellar furrow, the anterior pair slightly in front of lateral furrow 2p. A conspicuous spine of similar size is that on the fixed cheek outside the anterolateral angle of the glabella, and others are on the fixed cheek behind the eye lobe, and a well-spaced row of these spines along the lateral and anterior cephalic borders, directed outward. On the under side of these same borders long slim spines are directed downwards and outwards (Pl. 8, fig. 13).

Thoracic segments having axial rings similar to occipital ring, i.e. posterior margin curves strongly back and projects behind the rest of the segment, and anterolateral corner of ring is only faintly subdivided from anterior band of pleura. Pleurae extend out horizontally, the tips bent down and pointed; pleural furrow runs in a curve convex forwards close to the anterior edge of the flat, inner part and out on to the middle of the tip. Anterior and posterior bands gently convex, the posterior being the wider (exs.), flanges narrow and flat.

Discussion. Glaphurus divisus n. sp. differs from the type species *G. pustulatus* (Walcott, 1877; Ulrich, 1930, pp. 42-44, pl. 7, figs. 15, 16; pl. 8, figs. 1-11) in that the glabella is more convex longitudinally, the preglabellar field more steeply bent down, and in anterior view the upward curvature toward the midline of the preglabellar furrow and anterior border is less strong. In *G. pustulatus* the genal angle is rounded, the librigenal spine directed outward (Whittington, *in* Moore, 1959, fig. 221, 1a, b), in *G. divisus* the border is broad at the genal angle,

projects back, and the spine is backwardly directed. Three pairs of short spines are present on the glabella in front of the occiiptal ring of both species. If these spines are related to segmentation, the presence of two pairs between the occipital furrow and the level of lateral glabellar furrows 2p (Pl. 9, fig. 3) confirms the suggestion that the lateral glabellar lobe is bicomposite. The strong subdivision of the eye lobe in *G. divisus,* the visual surface projecting like a blister from the steep lateral slope of the lobe, seems to be peculiar to this species. Jaanusson (1956, p. 39) pointed out that the suture of *Glaphurus* was levisellid in type. The present material seems to bear this out. Thoracic segments in the two species are extremely alike.

Ulrich (1930, pp. 8-9) placed *Glaphurus* in the Telephinidae because of similarities in the thorax and pygidia of the two genera. Jaanusson (1956, p. 39) considers that the small eye lobe, large fixed cheek and broad (sag. and exs.) preglabellar field preclude the possibility that *Glaphurus* is related to telephinids, though some relationship between the two groups has been maintained in the Treatise (Moore, 1959, pp. O 294-O 298). I am inclined to agree with Jaanusson, but not with his suggestion that *Glaphurus* may be related to the catillicephalids, since these genera (Rasetti, 1954) have the doublure crossed either by connective sutures or a median suture. I have no new suggestions to make as to the affinities of *Glaphurus* and its presumed relationship to *Glaphurina.*

Family NILEIDAE Angelin, 1854

Genus NILEUS Dalman, 1827

NILEUS AFFINIS Billings, 1865

Plate 9, figures 7, 9-12; Plate 10, figures 1-7, 10, 13

Billings, 1865, p. 275, figs. 261a, b.

Lectotype (here selected). GSC 889a, complete enrolled exoskeleton from Island of Orleans, near Quebec City. Original of Billings, 1865, p. 274, fig. 261 a, b.

Other material. Billings recorded the species as coming from the Quebec group, Division "P, Cow Head, Newfoundland; also on the Island of Orleans." The supposed syntypes include two specimens, the second, GSC 889, an extended, incomplete exoskeleton. Both are labelled as coming from the Island of Orleans and collected by Sir William E. Logan. There is no specimen

from Cow Head (collected by J. Richardson), but the enrolled specimen seems unquestionably to be the original of Billings' figure. The Lévis formation outcrops on the south side of Orleans Island (Osborne, 1956, p. 181, map), and presumably the specimens came from a boulder in limestone conglomerates. The possibility cannot be excluded that either, or even both, came from western Newfoundland, for the material from Lower Head appears to be identical.

Description. Cephalon subsemicircular in outline, gently and evenly convex, the axial and preglabellar furrows not impressed so that distally the glabella slopes down without any break into the cheek and the palpebral lobe, and anteriorly the glabella curves down over the margin to form a continuous structure with the ventrally convex doublure. A slight indentation of the posterior margin at the axial articulating socket (Pl. 10, fig. 1) marks the lateral margin of the glabella. Glabella without furrows, small median tubercle visible on internal mould at a point in line with posterior edge of eye lobe. Cheek triangular in outline, straight posterior margin and rounded genal angle, distally it curves down over the margin to form a continuous structure with the doublure. Eye lobe of length about half of that of cephalon, moderately curved, shallow furrow in cheek outside eye surface. Laterally the doublure is narrow and abruptly flexed up, anterolaterally and anteriorly it is broad, so that in the midline its width is half the length of the cephalon. Shallow median notch in the inner margin, along which hypostomal suture runs. Anterior branches of suture nileid in form (Pl. 10, figs. 3, 10), the branches uniting in a smooth curve along the anterior edge of the cephalon. Posterior branch of the suture (Pl. 10, fig. 1) runs backward and slightly outward for a short distance, then curves to run outward and backward, at about 45° to the sagittal line, to the margin. Doublure without median or connective sutures. Dorsal external surface smooth. Doublure traversed by raised lines running subparallel to the margins.

Thorax of seven segments, each segment gently and evenly convex with only a very slight depression, and the slight notch at the articulating processes, indicating the position of the axial furrows. Axis about half the total width. Pleurae without pleural furrow, bluntly terminated, broad facet. Pygidium twice as wide as long, gently and evenly convex, axis not outlined, slight concavity in pleural regions posterolaterally. External surface of posterior half of axial rings of thorax crossed by two

raised lines, the anterior of which continues on to the pleura behind the facet, on which portion there are one or two additional such lines. On the facet the terrace lines run forward and outward in a curving course, as they do on the doublure, which extends in to the axial furrow. On the pygidium, well-spaced, raised lines run out to the margin or subparallel to the margin on the pleural regions.

Discussion. Whatever the exact locality from which the syntypes came, there is no question but that the Newfoundland specimens belong to the same species. *N. affinis* differs from *N. scrutator* Billings, 1865 (pp. 274-275, fig. 260, from "Division P, Portland Creek") in the characters that Billings mentions, except that the smoothness or otherwise of the visual surface of the eye is probably dependent on preservation. Specimens of the type species of *Nileus, N. armadillo,* from the "Lower Red Limestone" (i.e. the Limbata and part of the Vaginatum limestones, of Upper Arenig age, see Thorslund, 1960, p. 82) at Kinnekulle, Sweden, in the Museum of Comparative Zoology collections, show that *N. affinis* differs principally in that the eye lobe does not reach as close to the posterior margin of the cephalon, the anterior and anterolateral edge of the cephalon is gently rounded, not sharply folded, and the doublure is wider (sag. and exs.). In other respects, particularly in the absence of definition of the axial furrows, the two species are extremely alike. Older species of *Nileus* (Tjernvik, 1956, pp. 208-211, text-fig. 33, pl. 2, figs. 12-23) from Sweden have the axial furrows somewhat better defined on the cephalon and pygidium of certain species. *N. armadillo* has eight thoracic segments, not seven as in the American species. I do not feel that this and other differences between American and Swedish species justify the erection of a new genus. Species similar to that from Lower Head occur in the Table Head Series and beds of the *Anomalorthis* zone of the Whiterock Stage (equals zone N of Hintze, 1953) of Nevada. It is hoped that study of material from these localities may clarify the affinities of these species.

Family BATHYURIDAE Walcott, 1886

Genus BATHYURELLUS Billings, 1865

BATHYURELLUS NITIDUS Billings, 1865

Plate 10, figures 8, 9, 11, 12, 14-17; Plate 11, figures 1-12, 14, 15

Billings, 1865, pp. 265-266, fig. 249.

Whittington, 1953b, p. 661, pl. 67, figs. 9, 13-15; text-fig. 4.

Description. The present abundant material enables some additions to be made to my previous description. The smallest specimens (Pl. 11, figs. 8-10) appear to belong to degree 6. The glabella is relatively short and strongly convex, the highest point midway between occipital furrow and anterior margin. The genal spine is broad at the base and long. The transitory pygidium is incomplete, but shows at least the first four segments outlined by ring and interpleural furrows, and bearing shallow pleural furrows. A degree 8 specimen (Pl. 11, figs. 11, 14) has the glabella relatively longer, the anterior part showing the bluntly pointed outline, and in longitudinal profile it is less convex. The genal spine is narrower (tr.) and backwardly rather than slightly outwardly directed. Thorax is much as in holaspides. The first segment of the transitory pygidium is completely formed, the posterior margin being extremely faintly indicated on the inner pleural regions. Larger cephala, such as one of the same size as the lectotype (Pl. 10, fig. 9), have the glabella less convex and reaching further forward, and the genal spine is smaller. All cephala examined of this size (approximately 5 mm. in sagittal length) and all smaller ones have the genal spines. In cephala of larger size there appear to be two types, distinguished only by the difference in the appearance of the genal angle. In one type (Pl. 10, figs. 14, 15, 17) the posterior margin of the cheek runs straight outward and slightly backward, distally curving forward to meet the backwardly directed lateral margin. The genal angle is thus rounded, the broad, externally convex doublure extending beneath it, and narrowing inward rapidly beneath the posterior border as the inner margin curves to reach the posterior margin at the point where it is crossed by the posterior branch of the suture. In the other type of cephalon (Pl. 11, figs. 4, 6, 7, 12) the posterior margin curves outward and backward to meet the lateral margin in an acute point, so that the genal angle forms a small, blunt, backwardly-projecting prolongation. Beneath this genal angle, and the lateral and posterior borders, the doublure is similar in appearance to that of the other type of cephalon. There are insufficient well-preserved specimens to provide any figures on relative numbers of these two types of cephala. They appear to be present in sizes up to the maximum seen, of a length of approximately 13 mm.

The cephalic doublure is illustrated here, but previously no sutures were observed crossing it. One or two specimens in the

present material (Pl. 11, fig. 15) show that the doublure in front of the glabella is crossed by connective sutures. These sutures commence at the outer margin at a point approximately in line with the axial furrows, and run straight inward and backward to intersect at about half the width of the doublure. A rostral plate of sub-triangular shape is thus isolated. The two connective sutures continue as a single median suture inward across the remainder of the doublure to the inner margin, which is turned up vertically to lie close beneath the dorsal exoskeleton and a short distance in front of the preglabellar furrow (Pl. 11, figs. 6, 7).

Included in the present material are eight isolated and incomplete large pygidia, attaining a maximum width of 35 mm. These pygidia (Pl. 11, figs. 2, 3) are like smaller ones, the axis reaching back to approximately half the length, the pleural regions adjacent to the axis horizontal, outside here curving downward and outward to the flattened distal portion. Three pleural furrows are seen on the inner part of the pleural regions, and three interpleural extend on to the outer part. A faint fourth interpleural furrow may be present on the outer part of the pleural regions, behind the axis. The doublure (Pl. 11, figs. 1, 5) is broad, flat peripherally, the inner part turned upward so that the inner margin lies immediately beneath the boundary between inner and outer parts of the pleural regions, and beneath the tip of the axis, where it is excavated by a shallow notch.

Genus Uromystrum Whittington, 1953

Discussion. *Uromystrum fraternum* is similar to the type species *U. validum,* both being characterized by the high cephalon, the long, broad-based genal spine, the glabella without furrows and expanding slightly in front of the eye lobes, the latter situated far back, the anterior branches of the suture widely divergent and the outer parts of the pleural regions of thorax and pygidium gently concave. *U. formosum* and *U. patulum* n. sp. are placed in this genus, though the parallel-sided glabella and position of the eye lobes approach that seen in *Bathyurellus nitidus.*

Few of the available specimens of species of *Uromystrum* show the anterior cephalic doublure. One of *U. validum* (Whittington, 1953b, pl. 67, fig. 2) shows no signs of sutures crossing this doublure, and the same is true of one specimen of *U. patulum*

n. sp. (Pl. 14, fig. 1). In one specimen herein referred to *U. formosum* the inner, curled-under part of the anterior cephalic doublure (Pl. 13, fig. 6) is crossed by a median suture. Possibly in *Uromystrum* the doublure was crossed by connective sutures which converged backwards to a single median suture, like the suture displayed by one specimen of *Bathyurellus nitidus* (Pl. 11, fig. 15).

Uromystrum fraternum (Billings, 1865)

Plate 12, figures 1-7, 10, 12, 13

Billings, 1865, pp. 267-268, fig. 251a, b.
Whittington, 1953b, p. 659.

Lectotype. GSC 643, incomplete cranidium with some of the exoskeleton adhering (Pl. 12, figs. 1-3), original of Billings, figure 251a, from "P, Quebec Group, Cow Head, Newfoundland." Collected by J. Richardson.

Other material. GSC 643a, incomplete pygidium, doubtfully the original of Billings, figure 251b, from same horizon and locality as lectotype. A cranidium, fragments of four additional cranidia, and four pygidia were obtained by Kindle from light-colored granular limestone at Lower Head. There is also an incomplete cranidium, GSC field number 452, in a darker, brown granular limestone which is labelled as from "Cow Head, Newfoundland," and appears to belong to this species.

Description. Maximum width of glabella at posterior margin, axial furrow curves inward and forward so that minimum width of glabella is between midpoint of eye lobes, in front of here it expands slightly and then tapers to the bluntly rounded point. Axial furrows are shallow but distinct, glabella gently convex transversely, without occipital or lateral glabellar furrows. Fixed cheek is curved to slope steeply downward, and continuous with the narrow preglabellar field. Distally cheek is flexed abruptly at its junction with the flat, outward-sloping border, which border is widest (sag.) anteriorly. Posterior margin of cheek curves outward and backward, no posterior border furrow. Palpebral lobe situated close to glabella, gently convex and without rim, and forming with innermost part of cheek a gently domed region which slopes gently outward and more steeply back to posterior margin. External surface apparently smooth; on internal mould of cheek there are scattered shallow pits.

Pygidium with gently convex axis extending some three-quarters of the length, defined by axial furrows which are shallow anteriorly and die out posteriorly so that tip of axis is vaguely defined. Transverse articulating furrow succeeded by four transversely-directed, shallow axial furrows, which become successively shallower posteriorly. Pleural regions adjacent to axis slope gently outward, distally slope increases and then is reversed adjacent to margin so that outer part of regions is gently concave, the concavity most marked behind the axis. Doublure extends in to tip of axis, and is moderately convex ventrally; on moulds the corresponding concavity is greater than that of the outer part of the pleural regions. First pleural furrow broad, shallow, running almost directly outward, curving slightly backward on outer part of region. Faint second and third pleural furrows are present only on inner part of pleural region. External surface apparently smooth, shallow, faint pitting on internal mould. Doublure bearing terrace lines that run subparallel to the margins.

Discussion. Billings (1865, pp. 267-268) and Raymond (1925, p. 74) were aware that *U. fraternum* was extremely similar to the type species *U. validum* (Whittington, 1953b, pp. 659-660, pl. 67, figs. 1-5; text-fig. 1a), from the Lower Table Head Series at Pointe Riche. The present material seems to show that *U. fraternum* may be distinguished from the type species by the following minor characters: the glabella has the maximum width at the posterior margin, narrows to a minimum width between the eye lobes and expands in front of this, and entirely lacks the occipital furrow; it is also better defined anteriorly by slightly deeper axial and preglabellar furrows. The anterior border is better defined, the change in slope between cheek and border being more abrupt and at a greater angle. The eye lobe appears to be situated slightly farther forward and the slope behind it apparently less steep. It is not certain that the pygidium associated by Billings with the cranidium of *U. fraternum* is the correct one, since no complete specimen is known. Assuming that it is, it differs from that of *U. validum* in that the axis is relatively longer, and the pleural regions are far less concave. The doublure in the two specimens is similar but relatively wider in the type species because it extends in to the tip of the axis.

Uromystrum formosum (Billings, 1865)

Plate 12, figures 8, 9, 11, 14; Plate 13, figures 1-6

Bathyurellus formosus Billings, 1865, pp. 266-267, fig. 250.
B. formosus, Whittington, 1953b, p. 661.

Lectotype. GSC 664, incomplete cephalon with five thoracic segments articulated (Pl. 13, figs. 1, 2, 4), from "P, Quebec Group, Cow Head, Newfoundland," probable original of Billings' figure 250, though this figure has the right side of the cephalon restored and shows no thoracic segments.

Other material. GSC 664a, incomplete cranidium, from "P, Quebec Group, Cow Head, Newfoundland," one of the specimens studied by Billings. Two incomplete cephala and two incomplete cranidia were collected by Kindle and Whittington from Lower Head.

Description. The deep cephalon, with its broad genal prolongations, and the thoracic segments, the first two of which are bent down only slightly distally (the outer parts of the next three segments are broken off), are like those of *Uromystrum validum* and *U. fraternum.* The glabella, however, has a deep occipital furrow and is parallel-sided, with a bluntly pointed anterior lobe, not having the lateral margin running in a curve concave outward, nor is the anterior lobe expanded. The eye lobes are about opposite the midlength of the glabella, farther forward than in typical *Uromystrum,* and the palpebral lobe and adjacent part of fixed cheek is not convex but flattened. The glabella and eye lobes are thus more like those of *Bathyurellus nitidus,* but this species is referred to *Uromystrum* because of the other cephalic characters. In addition, the anterior branches of the suture are widely divergent, much as they are in *U. validum.* Distinctive of this species is the abrupt flexure of the peripheral parts of the cheeks and preglabellar area, giving a border which is narrow (sag. and exs.) anteriorly and progressively diminishes in width laterally, but extends on to the prolongation for a considerable part of its length. One of the new specimens (Pl. 13, figs. 3, 5, 6) shows the inner, curled-under part of the anterior cephalic doublure, which is crossed by the median suture. Laterally the doublure becomes wider (tr.). Posterior border furrow shallow, running straight out parallel to the posterior margin, dying out before reaching the posterior branch of the suture. External surface of the lectotype shows scattered pits in the glabella in front of the occipital furrow, and anastomosing

terrace lines in front of this furrow. Similar lines run transversely on the inner part of the genal prolongation, and in curves concentric forward on the axial rings as well as diagonally on the pleurae.

Uromystrum patulum n. sp.

Plate 13, figures 7-11; Plate 14, figures 1, 2

Holotype. GSC 16204, cephalon with six segments articulated, immediately beneath which are parts of four segments and an incomplete pygidium of presumably the same species.

Other material. GSC 644, an external mould of an incomplete cranidium, from "P, Quebec Group, Cow Head, Newfoundland," was included by Billings in the syntypes of *Bathyurellus formosus,* but appears to belong in the new species.

Description. The deep cephalon, with its broad genal prolongations, the thorax and the pygidium, are typical of *Uromystrum.* The subparallel-sided glabella, which is bluntly rounded anteriorly and displays a well-marked occipital furrow, the position of the eye lobe at about the midlength of the glabella, and the flat fixed cheek inside the palpebral lobe, are like *U. formosum* but not the type species *U. validum.* Distinctive of this species is the broad, concave anterior and lateral border, which narrows at the base of the genal prolongation but is present for much of the length of this prolongation. This border, combined with the inflation at the base of the genal prolongations, gives this cephalon a distinctively broad and flattened appearance when compared to others of *Uromystrum.*

The cephalic doublure extends beneath the border, is flat distally, the inner part curled up so that the inner margin is close to the dorsal exoskeleton. Posterolaterally the inner margin curves around beneath the cheek to reach the posterior margin at a point inside the base of the genal prolongation (Pl. 13, fig. 11). On the dorsal exoskeleton a shallow groove follows the line of the inner edge of the doublure (Pl. 13, fig. 10), and at the base of the genal angle the prolongation is gently inflated outside this furrow. Anterior branch of suture directed outward from eye lobe at 45°, on border it curves inward to margin. Doublure not crossed by median or connective sutures in the one specimen which shows it (Pl. 14, fig. 1). Posterior branch of suture curves outward and backward from the eye lobe and reaches the posterior margin at the base of the prolongation.

Thorax of nine segments, the first four of these facetted to

fit beneath the inner margin of the genal prolongation. The remaining five segments have the outer part of the pleura gently concave and squarely ended. Shallow pleural furrow extends to the fulcrum. Pygidium with axis tapering rapidly to blunt termination at less than half length (sag.). Adjacent to axis inner part of pleural regions flat, outer parts broad and gently concave. Doublure extends under this region, the inner part turned up sharply so that the edge is close beneath the boundary between the inner and outer parts, and is gently notched at the termination of the axis. Three shallow pleural furrows on inner part of pleural regions, outer parts subdivided into gentle ridges and intervening furrows (by what appear to be the interpleural furrows) into four low, broad ridges.

External surface of exoskeleton not well preserved in any specimen, but raised anastomosing lines, running subparallel to the margins, traverse the outer parts of the pleural regions of the pygidium, and run diagonally across the genal prolongations. Doublure traversed by stronger lines. External surface of axis of pygidium apparently only revealing articulating furrow and faint first ring furrow. Internal moulds show three additional ring furrows, becoming progressively shallower posteriorly. These furrows are transverse and narrow.

Some of the cranidia referred to this species are 2 cm. in length (sag.), but do not seem to differ significantly from the smaller ones here figured.

Genus GONIOTELUS Ulrich, 1927

Discussion. I have redescribed the type species of this genus (see below and Pl. 35, figs. 2, 5, 7, 9), and discussed the relationship between this species and the species of *Goniotelina* Whittington and Ross, in Whittington, 1953b, and *Platyantyx* Whittington, 1953b. The two new, and a possible third, species of *Goniotelus* described below have characters that do not greatly modify the list of similarities and differences between *Goniotelina* and *Goniotelus* given previously. The eye lobe of *Goniotelus rostratus* n. sp. is like that of the type species of *Goniotelina* in its strong curvature and the narrow, convex palpebral rim. The glabella of *Goniotelus* sp. ind. expands forward rather like that of *Platyantyx*. This latter genus has the eye lobe farther out from the axial furrow, a wide cephalic border and long genal prolongations, and apparently nine thoracic segments, but is evidently related to both *Goniotelus* and *Goniotelina*.

GONIOTELUS PERSPICATOR (Billings, 1865)
Plate 35, figures 2, 5, 7, 9

Whittington, 1953b, pp. 662-663, pl. 68, figs. 1-10.

Discussion. Two cephala found at Lower Head seem to be identical with the type species. One cephalon, showing the anterior part of the rostral plate, is illustrated here.

GONIOTELUS KINDLEI n. sp.
Plate 14, figures 3-9

Holotype. GSC 16206, almost complete exoskeleton (Plate 14, figs. 3-6).

Description. None of the cephala exceeds a length (sag.) of 2 mm., and comparisons made here are with the smallest known specimens of the type species (Whittington, 1953b, pl. 68, figs. 3, 9), of length 3.4 mm. Outline and convexity of the glabella differs little from that of the type species, except that of *G. kindlei* n. sp. is more pointed anteriorly. Lateral glabellar furrows are not visible. Distinctive of this species is the relatively longer (sag. and exs.) preglabellar field and the flat upper surface of the outer part of the cephalic border. The cephalic doublure extends inward horizontally below the outer part of this border and then curls up vertically so that the inner margin is close beneath the boundary between border and cheek. Anteriorly the doublure bulges ventrally in a similar manner to that of the type species (compare Pl. 14, fig. 7, with Pl. 35, figs. 2, 7, 9, and Whittington, 1953b, pl. 68, fig. 10). The anterior branches of the facial suture run downward and slightly inward across the cheek, then curve over the border so that medially they meet and run along the margin of the border. Connective sutures run inward and backward along either side of the ventrally-bulging portion of the doublure (Pl. 14, fig. 8), outlining a rostral plate which must be similar in shape to that of the type species and of *Goniotelina williamsi* (Whittington, 1953b, pl. 68, figs. 11, 13). It is not known whether the connective sutures diverge as they approach the inner margin of the doublure, as they do in *G. williamsi*, but it is clear that the rostral plate has much the same curvature in a longitudinal direction.

Thorax of 10 segments, moderately convex axis tapering back. Inner part of pleurae horizontal, at fulcrum pleurae bent down, the outer parts tapering to a point and backwardly curved. Pleural furrow broad and shallow, running out to just

beyond the fulcrum where it ends against the inner edge of the facet. Pygidium triangular in outline, axis extended backward in a long, slim, horizontally-directed spine which has a length greater than that of the remainder of the pygidium. Two or three ring furrows, progressively shallower posteriorly, outline axial rings, the posterior part of the axis being smooth. Inner part of pleural region adjacent to anterior part of axis curves downward, and outer parts are steeply sloping. First two pleural furrows are short and shallow, first two interpleural furrows extend on to outer part of pleural region.

External surface of exoskeleton not well preserved, but low scattered tubercles visible on cheek outside eye lobe, and still fainter tuberculation visible on glabella of some specimens (Pl. 14, fig. 9). Doublure traversed by raised anastomosing lines.

Discussion. This species is like the type species in all essential characters, including the typical form of the junction between genal spine and cheek, and the extension of the cephalic border on to the outer margin of the proximal part of the genal spine, as well as the form of the pygidium.

Goniotelus rostratus n. sp.

Plate 14, figures 10-12; Plate 15, figures 1-4, 6

Holotype. GSC 16209, incomplete cephalon with two thoracic segments articulated (Plate 15, figs. 1, 2, 4).

Description. Cephala range from 2 to 4.5 mm. in sagittal length. The cephalon is more like that of the type species than that of *G. kindlei* n. sp., but is distinguished at once by the more pointed outline of the glabella and the resulting relatively wider preglabellar field laterally (compare Pl. 15, fig. 4 with Pl. 35, fig. 2), the strongly curved eye lobe with the wire-like, narrow, palpebral rim, and convexity of the eye surface, and the more bent-down outer part of the cheek. The narrow (tr.), bluntly-pointed and downwardly-directed convex rostral plate is also characteristic of this species. Smooth areas on the glabella, opposite the midpoint and anterior end of the eye lobe, curving inward and backward (Pl. 15, fig. 1), define lateral glabellar furrows 1p and 2p. The cephalic borders and genal spine are similar to those of the type species. Tuberculation of the external surface, inside the borders and not in the furrows, is conspicuous.

Comparison of the smallest cephalon (Pl. 15, figs. 3, 6) with cephala of *G. kindlei* n. sp. (Pl. 14, figs. 3, 4) shows that this

species is distinguished by the shape and convexity of the eye lobe, the narrower cephalic border, the prominence of the ventral projection of the rostral plate, and the tuberculation.

Thoracic segments of this species are of typical form; on the external surface tuberculation similar to that of the cephalon is present on the axial rings and convex pleural bands.

Goniotelus sp. ind.

Plate 15, figures 5, 7, 8

Description. This single cephalon is most like that of *G. rostratus* n. sp., and larger than known specimens of the latter species. The glabella expands forward in front of the occipital ring, is bluntly rounded anteriorly, and more strongly convex than that of *G. rostratus* n. sp. Lateral glabellar furrows 1p and 2p are indicated by faint, broad depressions, which are not smooth but tuberculate like the remainder of the glabella. The eye lobe is relatively short, the outline of the palpebral rim acutely curved, and inside this rim is a broad, shallow palpebral furrow. The anterior doublure is not well preserved, but appears to lack the strong downward bulge of the rostral plate of *G. rostratus.*

Though this cephalon is larger than any known of *G. rostratus* n. sp., the differences do not make it likely that it belongs to this species. The forwardly expanding glabella and the relatively short (exs.) eye lobe are characters typical of *Platyantyx arcuata* (Whittington, 1953b, pl. 68, figs. 22, 25), but in this species the eye lobe is relatively farther away from the axial furrow and the cephalic border is quite different.

Family LEIOSTEGIIDAE Bradley, 1925

Genus Lloydia Vogdes, 1890

Lloydia saffordi (Billings, 1860)

Plate 11, figures 13, 16-18

Description. Two incomplete pygidia attributed to this species were obtained by J. Richardson from "Quebec Group, Cow Head" (GSC 639, 639a). The species is based on a cranidium (Billings, 1860, pp. 320-321, fig. 24; 1865, pp. 411-412, fig. 393), which came from the conglomerates at Point Lévis, Quebec. It has been recorded by Clark (1924, pp. 99-100) from boulders of Beekmantown age at Point Lévis, and is said by Raymond

(1913, p. 67) to be common in the Beekmantown at Philipsburg, Quebec. Exactly where the present specimens came from is uncertain, but additional specimens have not been obtained from the white limestone at Lower Head. According to Billings (1865, p. 259) the species occurs "in white limestone, associated with great abundance of *Maclurea ponderosa,*" and gastropods of this type occur at Lower Head and in conglomerates to the north (Kindle and Whittington, 1958, pp. 334-335, text-fig. 8). We have collected a pygidium similar to that described here only from a conglomerate of early Ordovician age (1958, p. 324, fig. 3).

The specimens figured here are similar to that figured by Raymond (1913, pl. 7, fig. 16), which presumably came from Quebec. Axis tapers gradually and reaches back to margin of border. Articulating furrow and first ring furrow shallow on external surface; five additional extremely shallow ring furrows are faint or absent on the external surface but may be observed on the internal mould. Pleural regions curved down to the broad, shallow border furrow, outside which is the flattened, outward-sloping border. Pleural regions crossed only by the broad, shallow pleural furrow, which does not extend beyond the border furrow. Doublure (Pl. 11, fig. 18) extends inward as far as border furrow, outer part is flat, inner part is flexed up vertically and as it approaches the dorsal exoskeleton is curved inward and forward. External surface smooth.

Family ILLAENIDAE Hawle and Corda, 1847

Subfamily ILLAENINAE Hawle and Corda, 1847

Genus ILLAENUS Dalman, 1827

Discussion. In recent years the difficult taxonomic problems presented by illaenids have been attacked by Jaanusson (1954, 1957; *in* Moore, 1959, pp. 0 372-0 376) and Šnajdr (1957), both of these authors laying emphasis on characters of the rostral plate, hypostome, and pygidial doublure. In the four species described below (omitting consideration of the two indeterminate species) the nature of the rostral plate and pygidial doublure has been determined (Text-fig. 4), but unfortunately no hypostome has been found in place, and only one isolated specimen. Until more is known of illaenid hypostomes, how they are attached to the remainder of the exoskeleton and their attitude to it, this part of the exoskeleton can scarcely be used in classification.

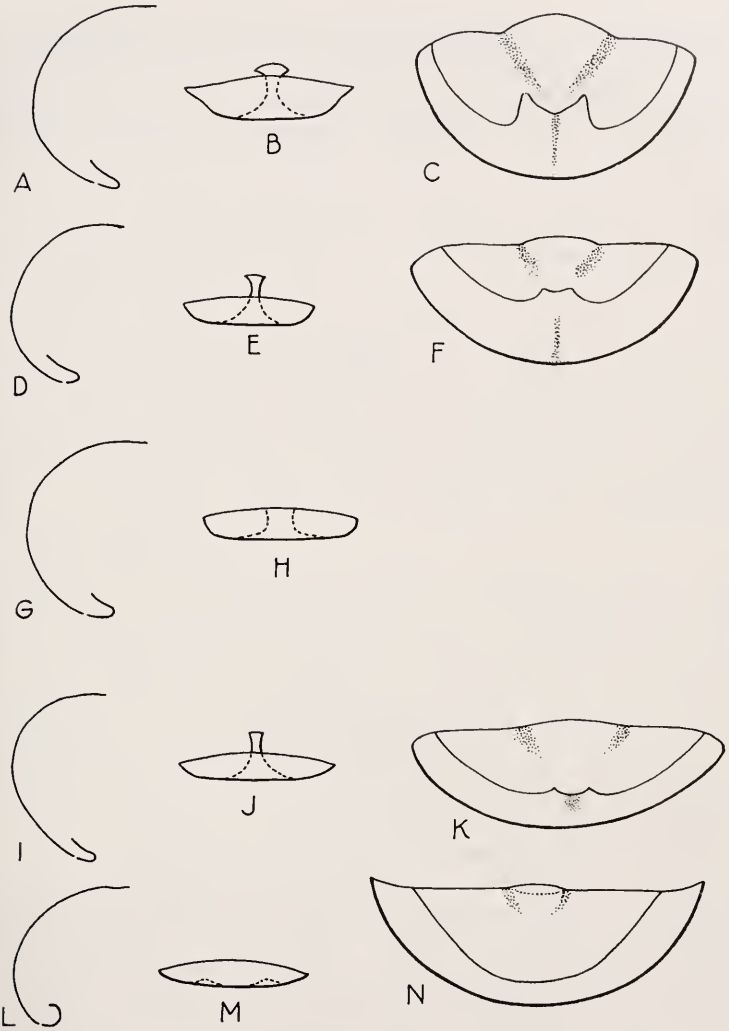

FIG. 4. Sagittal section of cephalon, lacking hypostome, rostral plate (in ventral view), and pygidial doublure of five illaenid species. A, B, C, *Illaenus tumidifrons* Billings, compare Plate 15, figures 9-11; Plate 16, figure 16. D, E, F, *Illaenus consobrinus* Billings, compare Plate 17, figures 7, 9-11, 14, 15. G, H, *Illaenus bucculentus* n. sp., compare Plate 18, figures 12-15. Pygidium of this species is unknown. I, J, K, *Illaenus spiculatus* n. sp., compare Plate 20, figures 8, 10-12. L, M, N, *Harpillaenus arcuatus* (Billings), compare Plate 20, figure 13; Plate 21, figures 12-15.

The presence of the rostral flange in *Illaenus tumidifrons*, *I. consobrinus*, *I. bucculentus* and *I. spiculatus* (Text-fig. 4) suggests that these species belong in the subfamily Illaeninae (Jaanusson, 1957, p. 109; 1959, *in* Moore, p. 0 372). Other features of the exoskeletons suggest that they should be placed in the genus *Illaenus*, for the large eyes seem to exclude them from *Cekovia* Šnajdr (1957, pp. 175-187) and the form of the free cheeks and the short pygidial axis excludes them from *Thaleops* (Jaanusson, 1959, *in* Moore, p. 0 374). Jaanusson (1954, pp. 574-575; 1957, pp. 109-113) divided the species placed in *Illaenus* into five groups, and the present species appear to be allied to his group of *I. sarsi*. These groups were based on the outline of the inner margin of the pygidial doublure, and in three of the Newfoundland species this outline (Text-fig. 4) has a forwardly projecting median tongue which has lateral points and a shallow median notch. This type of margin is seen in *I. sarsi* (Jaanusson, 1957, text-fig. 14a). However, while *I. sarsi* has the cephalic doublure curled under and a rostral flange (Jaanusson, 1954, pl. 2, figs. 1, 2; text-fig. 2), the hypostomal suture runs in a smooth, gentle curve. The corresponding margin of the doublure in all the Newfoundland species is bluntly pointed, so that the hypostome cannot have fitted in exactly the same way as in *I. sarsi*. This outline of the margin of the anterior cephalic doublure is a feature that *I. tumidifrons* and other species described here share with *Holotrachelus punctillosus* (Jaanusson, 1959, *in* Moore, fig. 289c), a peculiar and taxonomically isolated species. It is evident that the single feature of the outline of the inner margin of the pygidial doublure is hardly an adequate criterion for separating groups of species of *Illaenus*.

Jaanusson and Šnajdr have regarded the number of thoracic segments as an important generic character. As reviewed in more detail below, *Illaenus spiculatus* n. sp. is quite like *I. consobrinus* and *I. bucculentus* n. sp. in most features of the exoskeleton, but has only 8, not 10 thoracic segments. Yet *I. spiculatus* does not seem to belong in any illaenid genus having 8 thoracic segments, and I consider unwarranted the erection of a new genus for its reception, based on this single character.

The peculiarities exhibited by *"Illaenus" arcuatus*, however, do seem to justify the erection of a new genus, and the rostral plate and pygidial doublure set it apart from the other species considered here. Within Jaanusson's scheme (*in* Moore, 1959) it is difficult to decide to which subfamily it may belong.

Meraspides of two species (Pl. 16, figs. 6, 7, 9; Pl. 20, figs. 1-9) are described. The club-shaped glabella typical of illaenimids is faintly outlined, and the cheek bears a librigenal spine. In the later degrees, the number of segments in the thorax plus the number outlined on the anterior part of the transitory pygidium is equal to the specific holaspid number.

Illaenus tumidifrons Billings, 1865

Plate 15, figures 9-13; Plate 16; Text-figure 4 A-C.

Billings, 1865, pp. 278-279, figs. 264a, b.

Lectotype (here selected). GSC 662j, small enrolled individual with exoskeleton adhering (Pl. 16, figs. 1-5), from "P, Cow Head," which may be the original of Billings figure 264b. The syntypes, GSC 662, 662a-m, all from "P, Cow Head," include three enrolled and one extended exoskeleton, a cephalon with 9 segments articulated, eight cephala, and one pygidium. It is not possible to decide which specimens may be the originals of Billings figure 264a.

Description. Cephalon sub-quarter spherical in shape. In front of the eye lobes the exoskeleton curves downward, and the most anterior portion is flattened and faces ventrally (Pl. 16, fig. 14); laterally this ventral-facing portion is separated by a gentle flexure from the vertical slope of the cheek. Glabella of width at the posterior margin about half the total width of the cephalon, defined by broad, sub-parallel axial furrow that dies out about opposite the mid-point of the eye lobe; at the anterior extremity the axial furrow is slightly widened and deepened, with a flat base. Large, bean-shaped eye lobe convex, midpoint situated at about half the length of the cephalon, and high up on the cheek; outside eye lobe cheek slopes vertically. Posterior margin of cheek is transverse for a short distance adjacent to the axial furrow, then turns to run outward and backward; opposite the tip of the first thoracic pleurae there is a slight notch in the margin, outside here it curves outward and then forward to the rounded genal angle. Posterior branch of the facial suture runs outward and backward to the shallow notch in the posterior margin. Anterior branch runs at first forward, on vertical slope of anterior part of cephalon it curves inward to meet rostral suture at an oblique angle (Pl. 15, fig. 9). Doublure is narrow, semitubular around margins of free cheek, except at genal angle and along posterior margin, where outer part is flattened and close beneath dorsal exoskeleton (Pl. 15,

fig. 10). During enrollment the tips of the thoracic pleurae lie against this flattened strip, the vincular furrow. Anteriorly the doublure becomes widest, where the inner margin is extended in a point that projects forward above the ventrally-facing part of the dorsal exoskeleton (Pl. 15, fig. 11). Connective sutures outline a rostral plate which is trapezoidal in shape on the ventrally-facing anterior part of the dorsal exoskeleton (Pl. 15, fig. 9; Text-fig. 4B). The connective sutures converge as they run over the curled-under part of the doublure, approach closely, and then diverge before reaching the inner margin (Pl. 15, fig. 11). Thus they have a course across the doublure that is a curve concave outward, and the rostral plate bears an axe-shaped rostral flange. Hypostome unknown.

Thorax of ten segments, axis narrowing slightly backward, moderately convex. Inner part of pleurae horizontal, outer part bent to slope gently downward, tips of pleurae rounded and facetted. Pygidium subsemicircular in outline, moderately convex (tr. and sag.). Axis extends less than half the length and narrows rapidly to rounded tip. Anterior margin of pleural region angulate, the anterolateral corner broadly facetted. Doublure (Pl. 16, fig. 16; Text-fig. 4C) broad, with a shallow sagittal fold, and a tongue which projects forward so that the anterior margin lies immediately beneath the furrow defining the tip of the axis. The tongue is hence forked, the margin between the points deeply concave forward. External surface of exoskeleton bearing raised anastomosing lines which on the cephalon and pygidium run sub-parallel to the outer margins. On the axial rings of the thorax the lines run in curves convex forward, on the pleurae they run diagonally. Between the lines on the cheek, outside the eye lobe, are scattered shallow pits. Doublure traversed by anastomosing lines that run sub-parallel to the margin.

Development. A poorly preserved meraspid degree six and a degree eight meraspid (Pl. 16, figs. 6, 7, 9) are known. In the former the axis of the pygidium, which extends relatively far back, has four axial rings clearly defined by axial furrows, and four pairs of pleurae defined by shallow interpleural furrows on the pleural regions. In the degree eight meraspid only two such ring furrows and interpleural furrows are visible. Characteristic of the meraspid is the relatively narrow, parallel-sided glabella, the axial furrows faint and divergent in front of the eye lobes, and the free cheek which slopes less steeply, is relatively narrower (tr.) and does not project behind the fixed

cheek. The genal angle is rounded, but there is a slight convexity at the angle (Pl. 16, fig. 6) which suggests that in earlier degrees this angle may have borne a short, blunt spine.

Illaenus consobrinus Billings, 1865

Plate 17; Plate 18, figures 1-3, 5; Text-figure 4 D-F

Billings, 1865, pp. 280-281, fig. 266a, b.

Holotype. GSC 676c, the original of Billings, figure 266a, b, from "P, Cow Head." The original material includes also GSC 676, 676 b, d, e, four internal moulds of the cephalon, and 676a, a pygidium which may not belong to this species.

Description. Cephalon in dorsal aspect, crescentic in outline, width more than twice length (sag.), longitudinal convexity moderately strong and even, in a transverse direction the region between the eye lobes gently convex, outside eye lobe descending steeply to vertical lateral slope. Broad glabella defined by axial furrows which display a sigmoidal curvature, the furrow dying out opposite the eye lobe in a crescentic depression which has its strongest and convex curvature facing inward. Eye lobe moderate in size, situated relatively close to posterior margin; along transverse line passing through midpoint of eye lobes the distance between lobe and axial furrow is about half width of glabella. Posterolateral part of cheek lobate in outline, projecting behind remainder of cephalon. Doublure wide beneath posterolateral portion of cheek (Pl. 17, fig. 16), interior edge curled up and forming a narrow ridge posterolaterally, this ridge defining the vincular furrow. Anterolaterally doublure is narrower and semitubular; toward midline inner edge is extended upward and backward by a blunt projection (Pl. 17, figs. 9, 11, 14). Posterior branch of suture runs straight outward and backward to cross posterior margin at the angle between the inner and outer parts of the cheek. Anterior branch of suture runs straight forward and slightly outward, approaching the anterior margin of the cephalon it curves through about 90° to meet the rostral suture at an oblique angle (Pl. 17, fig. 7). Rostral plate widest at anterior margin, the connective sutures converging strongly inward to the ventral surface of the doublure, then running close together up the median projection and diverging as they approach the tip of this projection. The rostral plate thus has a narrow, axe-shaped, backward and upward extension — the rostral flange (Pl. 17, fig. 14; Text-fig. 4E).

Thorax of 10 segments, the broad, gently convex axis tapering gradually backward. Inner, horizontal part of pleurae relatively broad (tr.), outer part much narrower and bent gently downward and facetted. Width (tr.) of this outer part of the pleura increases posteriorly so that the tips lie close to the doublure of the lobate, backwardly-extending part of the cheek. Pygidium subsemicircular in outline, gently convex axis defined only laterally by broad, shallow axial furrows. Longitudinal convexity is the stronger so that posterior part of pleural regions slopes steeply. Doublure broad, of width corresponding to the outer part of the pleurae of the thoracic segments, shallow median posterior ridge in the external surface, and forwardly projecting tongue which reaches to posterior tip of axis, where it is excavated in a shallow notch. External surface traversed by anastomosing raised lines which run subparallel to the anterior and lateral margins of the cephalon, posterior and posterolateral margins of the pygidium, on the axial region of cephalon and thorax running in curves gently convex forward. Raised anastomosing lines also traverse the external surface of the pygidial doublure.

Discussion. The smallest cephalon of *I. consobrinus* (Pl. 17, figs. 10, 12, 13) is 5.5 mm. in width (tr.), others such as the holotype reach 20 mm. in width and differ little in outline, convexity and proportions of parts. Fragmentary specimens which reach a width of approximately 50 mm. do not appear to be markedly different.

The lunate depression in the axial furrow opposite the eye lobe is the "lunette" (Whittington, 1954, p. 139) or lateral muscle scar (Jaanusson, 1954, pp. 551-552; Šnajdr, 1957, text-fig. 1) so characteristic of illaenids. The single isolated hypostome of illaenid type (Pl. 18, figs. 4, 7) may belong to this species or to *I. tumidifrons* and is not dissimilar to that of *I. sarsi* (Jaanusson, 1954, pl. 2, fig. 1). It is evident, however, that if this is the hypostome of *I. consobrinus* or *I. tumidifrons*, it cannot fit along the hypostomal suture against the rostral plate and doublure as it does in *I. sarsi* (Jaanusson, 1954, pl. 2, figs. 1, 2) because of the angulate shape of this margin in the Newfoundland species.

Illaenus bucculentus n. sp.

Plate 18, figures 6, 8-16; Text-figure 4G, H

Holotype. GSC 16227, incomplete cephalon with some of exoskeleton adhering (Pl. 18, figs. 6, 9, 12, 13).

Description. Twelve cephala that may be referred to this species are known, compared with 110 of *I. consobrinus.* The cephalon differs from that of *I. consobrinus* only in proportions and convexities of parts, as may be seen by comparing profiles. As the profile in anterior view shows (compare Pl. 18, fig. 9 with Pl. 17, fig. 4) the cheek outside the eye lobe slopes less steeply than that of *I. consobrinus.* As seen in dorsal profile (compare Pl. 18, figs. 6, 16, with Pl. 18, fig. 1; Pl. 17, fig. 1) the cheek curves back less strongly, and as a consequence the maximum width of the cephalon is across the posterior extremity and more than three times the length (sag.). The type of doublure (Pl. 18, fig. 15), with the median upward- and backwardly-directed projection, crossed by the curving connective sutures, the shape of the rostral plate with its flange, and the raised lines on the external surface, are similar in *I. bucculentus* and *I. consobrinus.*

Cephala of *I. bucculentus* are known of widths between approximately 9 and 18 mm., and the differences between the two species are evident through this size range. Thus the differences are not between growth stages of one species.

Illaenus sp. ind. 1

Plate 19 ,figures 1-4, 7

Description. The cephalon is more like that of *Illaenus tumidifrons* than that of *I. consobrinus,* but is distinguished from the former species by the less convex glabella, the much greater distance between the eye lobe and the axial furrow, and the different profile in lateral view (compare Pl. 19, fig. 3 with Pl. 16, fig. 14). The sharp flexure of the exoskeleton along the anterior margin, and the gently convex rim, are also distinctive. Other features of the cephalon, and particularly the course of the anterior branches of the suture and the outline of the rostral plate (the rostral flange is not known), are more like those of *I. consobrinus.* The thorax has a moderately convex axis, inner part of the pleurae of approximately the same length as the outer part — much as in *I. tumidifrons.*

Thus, although only five specimens of this type have been found, there seems no doubt of their distinctive characters.

Illaenus sp. ind. 2

Plate 19, figures 5, 6, 8, 9

Description. This cephalon is most like those included in *Illaenus* sp. ind. 1, differing in the convexly outward-curving

course of the axial furrows adjacent to the posterior margin, in the presence of the narrow palpebral rim, and in the convexity as seen in lateral profile — the exoskeleton in front of the eye lobes curves through about 90° to slope approximately vertically down to the narrow, forwardly-jutting rim. This rim is much more pronounced than that in *Illaenus* sp. ind. 1, and the gently convex, ventrally-facing doublure is wider, the rostral suture running parallel to it anteriorly and situated a considerable distance inside the margin. The illustrations show that this cephalon is quite distinct from those of *I. tumidifrons* and *I. consobrinus*. Raymond (1925, p. 109, pl. 7, figs. 8, 9) described *Illaenus marginalis* from the lower Table Head beds at Point Riche, a species which has a prominent rim around the anterior cephalic margin, but is otherwise unlike the present specimen.

Illaenus spiculatus n. sp.

Plate 19, figures 10-18; Plate 20, figures 1-12, 14; Text-figure 4 I-K

Holotype. GSC 16234, incomplete enrolled individual lacking exoskeleton (Pl. 19, figs. 10-12, 15, 17).

Description. The outline and convexity of the cephalon distinguishes it at once from those described above — the posterior margin deflected back only slightly distally, the moderate curvature of the anterior margin in dorsal view, the relatively large eye lobe, and the longitudinal curvature as seen in profile (Text-fig. 4 I), strongest immediately in front of the eye lobes where the cephalon curves through 90°. Glabella gently convex, defined by extremely shallow axial furrows which run inward and forward from the posterior margin and, between the eye lobes curve so that they diverge forward and die out. Posterior and lateral margins of cheek lie at a right angle (Pl. 19, fig. 14), the genal angle being sharply pointed and directed outward. Posterior branch of the suture runs strongly outward to cut the margin where the cheek begins to curve downward. Anterior branch of the suture runs straight downward and inward to the margin of the cephalon, where it curves slightly and meets the rostral suture. Rostral plate broad at anterior margin, narrowing rapidly backward and defined by the connective sutures which run inward and backward across the doublure in curves concave outward. The doublure is narrow, curled under, extended medially as a forwardly-directed blunt point (Pl. 20, fig. 10), posterolaterally becoming broader beneath the outer

part of the free cheek. Because of the curvature of the connective sutures the rostral flange is narrow and axe-shaped.

Thorax of 8 segments, gently convex axis narrowing slightly backward, inner part of pleurae horizontal, much wider (tr.) than outer part, which is bent to slope gently downward and is facetted. Pygidium broader than long, extremely faintly defined axis extends back about half the length. Larger, inner part of pleural regions horizontal, outer part curving downward. Doublure extends in beneath this outer part, and posteriorly is extended forward as a broad, notched tongue that reaches to a point immediately beneath the end of the axis. External surface apparently smooth, except around margin of cephalon and pygidium and on doublure, where there are raised anastomosing lines.

Development. Meraspides of degrees 4 (Pl. 20, figs. 1, 2), 5 (Pl. 20, figs. 4, 5, 7), and 7 (Pl. 20, figs. 3, 6, 8, 9) are known. The cephalon in these early stages is characterized by a slightly more convex glabella and by the free cheek being extended by a large outwardly- and slightly backwardly-directed genal spine. In the degree 4 meraspid it is notable that at least 7 additional segments are outlined by ring furrows on the axis, the first 5 of these segments being outlined by faint interpleural furrows on the pleural regions. At degree 5 only 3 such additional segments seem to be outlined, and at degree 7 only 1 such segment. One specimen of an isolated thorax of 7 segments and articulated pygidium shows 3 additional segments outlined on the transitory pygidium by axial rings and interpleural furrows, the most distinct of these latter being those of the tenth segment. The holotype (Pl. 19, fig. 15) and other specimens (Pl. 20, figs. 11, 14) have a thorax of 8 segments, and on the pleural regions of the pygidium is outlined what appears to be, because of its distance from the anterior margin of the pygidium, the interpleural furrow of the tenth segment continued part way on to the axis by the distal part of the ring furrow. No specimens have been found, however, with more than 8 segments in the thorax and the size of the larger ones is much greater than that of the meraspides, suggesting that they are truly holaspides.

Troedsson (1924, pp. 218-221, text-figs. 1-9) described transitory pygidia of an Upper Ordovician illaenid. He could not relate them to particular degrees, but their general appearance was like those described here.

Discussion. Illaenus spiculatus is like *I. consobrinus* and *I.*

bucculentus in the transversely elongate outline of the cephalon, in that the axial furrows converge forward from the posterior margin of the cephalon, the shape of the doublure, rostral plate and flange, course of the sutures, the form of the thoracic segments, and outline and convexity of the pygidium. The chief differences between the species are that in *I. spiculatus* the axial furrows diverge forward between the eye lobes, the genal angle of the cheek is pointed and directed outward, not prolonged far beyond the rest of the cephalon, and there are only 8 thoracic segments. These differences hardly seem to warrant placing *I. spiculatus* in a separate genus, although stress has been laid primarily on number of thoracic segments in erecting other genera of Illaeninae, e.g. *Nanillaenus* Jaanusson (1954, pp. 566-567) has 8 thoracic segments but in all other respects is extremely like *Thalcops* (the holotype of *N. conradi* has the margin of the free cheeks broken, but it seems probable that in this species, as in *T. ovata*, the cheek may have been extended in a spine). *Octillaenus* (Jaanusson, 1954, pp. 568-569) is an Upper Ordovician genus having eight thoracic segments and *I. spiculatus* does not resemble the type species in any respect. *Panderia* (Jaanusson, 1954, pp. 565-566) is another Ordovician genus having eight thoracic segments but again *I. spiculatus* does not appear to exhibit any of the characteristic features of the type species. Thus there does not seem to be any genus of Illaeninae possessing 8 thoracic segments in which *I. spiculatus* could be classified.

Subfamily uncertain

Harpillaenus n. gen.

Type species. Illaenus arcuatus Billings, 1865.

Diagnosis. Axis narrow. Glabella with occipital furrow, parallel-sided, not defined in front of eye lobes. Latter small, tusk-shaped free cheek curving back beside thorax and anterior part of pygidium. Cephalic doublure semi-tubular in cross section, shallow notch in inner edge of median portion, connective suture running in curve concave outward. Hypostome unknown. Thorax of nine or more segments, tips of pleurae of posterior segments curve forward. Pygidium gently convex, becoming gently concave distally, anterolateral corner pointed and directed outward and forward, inner edge of doublure runs in a smooth curve.

Discussion. The affinities of this species are far from clear. Is it an illaeninid despite the lack of a rostral flange? The

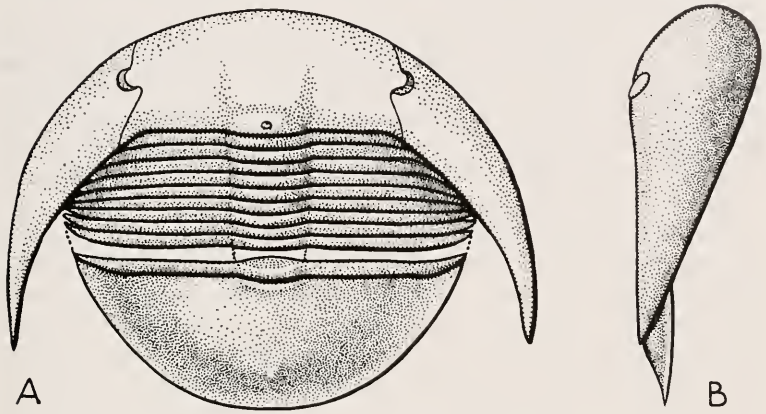

FIG. 5. *Harpillaenus arcuatus* (Billings). Restoration suggesting complete exoskeleton may have eleven thoracic segments, exact number unknown. A, dorsal view; B, right lateral view; *c.* X 2. Compare Plate 20, figures 15, 16; Plate 21, figures 1, 2, 6, 7, 11, 13.

ventral exoskeleton is not well known in this group, and the dorsal exoskeletal characters of *Harpillaenus* are not outside the range of known illaeninids. In the form of the rostral plate, as well as other characters, *Harpillaenus* does not resemble such Ordovician bumastinids as *Dysplanus, Platillaenus* (Jaanusson, 1954; *in* Moore, 1959) or *Bumastoides* (Whittington, 1954, pp. 138-139, pl. 62, figs. 16-18, 20, 25, 26, 29). There is some resemblance between *Harpillaenus* and the Upper Ordovician ectillaeninid *Zdicella* (Šnajdr, 1957, pp. 225-232, pl. 5, figs. 1-6; text-figs. 29, 30). This latter genus lacks eye lobes, but is characterised by the narrow axis, genal prolongations, and the entire margin of the inner edge of the pygidial doublure. The rostral plate of *Zdicella* is trapezoidal in outline, situated on the gently convex ventral doublure, the connective sutures not displaying a strong curvature which is concave outwards. The resemblances between the two genera may be an example of homeomorphy rather than an indication of relationship.

Harpillaenus arcuatus (Billings, 1865)

Plate 20, figures 13, 15, 16; Plate 21; Text-figures 4 L-N, 5

Billings, 1865, pp. 279-280, fig. 265.

Holotype. GSC 661b, incomplete cephalon lacking exoskeleton (Pl. 21, figs. 1-3) from "P, Cow Head," original of Billings figure 265. Included with the holotype are GSC 661, 661a, c-h, all pygidia (at the time I examined these specimens I had not identified the pygidium of this species, and so cannot say whether or not these specimens belong within it).

Description. Cephalon sickle-shaped in outline, genal prolongations long, curved, and tapering to point directly backward distally, length of these prolongations greater than sagittal length of cephalon, maximum width across prolongations four times the length (sag.) of the cephalon. On dorsal surface cephalon moderately convex, distally curving downward and inward so that anterior part overhangs margin and prolongations are tubular in section. Glabella narrow, width about one-sixth maximum width of cephalon, defined by extremely shallow, straight, parallel axial furrows that die out opposite the eye lobes. Occipital ring defined by broad, shallow, forwardly-curving occipital furrow, low median tubercle. Between axial furrows glabella gently convex. A transverse line joining the midpoint of the small eye lobes lies approximately at the mid-length (sag.) of cephalon. Fixed cheek of about same width as glabella. Posterior margin of fixed cheek transverse adjacent to glabella; at a point in line (exs.) with outer edge of eye lobe the posterior margin turns at an oblique angle into the base of the genal prolongation. Posterior branch of suture runs straight outward and backward to cut margin immediately outside this oblique angulation. Anterior branch of suture runs straight downward and inward, curves more strongly inward as it approaches the rostral suture, which it joins at an oblique angle. Anteriorly and anterolaterally the narrow cephalic doublure (Pl. 21, figs. 14, 15) is curved under so that it is semi-tubular in cross section, the inner margin being straight, with an extremely shallow, broad, median notch. Connective suture runs, in a curve which is concave outward, across this doublure; on the ventral and backward-facing portion it curves sharply to run backward and outward to intersect the margin at the outer edge of the shallow median notch. Rostral plate is thus semi-tubular in section, widest (tr.) at the anterior margin, the minimum width a short distance inside the posterior margin. Hypostome unknown. Beneath the free cheek

the inner margin of the doublure (Pl. 21, fig. 14), which is sharply bent upward, curves around to intersect the posterior margin immediately outside where it is crossed by the posterior branch of the suture. The doublure thus extends beneath the genal prolongations, which are tusk-like in shape.

Thorax of at least 9 segments, possibly 11 (Text-fig. 5). Narrow, gently convex axis tapering slightly backward. Pleurae much wider (exs.) than axial ring, flat, the tip narrowing to a point, the tips of the first 7 segments curving slightly upward and facetted. Tip of the pleura of the first segment short, abruptly cut off, that of succeeding segments slightly longer, so that each abuts against the inner edge of the genal prolongation. The outer part of the 8th and 9th thoracic segments is blade-like, tapering, and gently curved forward. As shown by the pygidium with two thoracic segments articulated (Pl. 21, fig. 7), the outer parts of the last two thoracic segments are similarly blade-like, tapering, and forwardly curved. Pygidium of width more than twice length (sag.), the narrow axis very gently convex, barely defined. On internal moulds (Pl. 20, fig. 13) the axis is likewise ill-defined, but appears to extend back to the inner edge of the doublure, and is divided by shallow ring furrows into five or six faint rings. Inner pleural regions gently convex, the outer pleural regions gently concave. Anterior margin of inner pleural region runs transversely; outside here it curves gently forward so that anterolateral corner of pygidium is acutely pointed, forwardly and outwardly directed. Doublure extends inward to margin between inner and outer parts of pleural regions, is gently convex on the ventral surface, the inner margin forming a smooth curve with an extremely faint, small, median depression.

In most of the specimens the larger part of the exoskeleton has been stripped off, but those to which some is still adhering suggest that the median part of the cephalon, axis and inner part of the pleural regions is smooth. Along the genal prolongations, the outer anterior and anterolateral parts of the cephalon, and the doublure, sub-parallel raised lines are present. In the anterior region of the cephalon, and on the doublure, these lines run sub-parallel to the margins. On the free cheek the lines curve downward towards the margin so that on the prolongations they run at an angle to these margins. Thus on the upper surface, along a line that is closer to the inner than the outer margin of the prolongation, the raised lines intersect, forming a pattern of inverted "V"s on this upper external surface (Pl. 21, fig. 6).

Family SCUTELLUIDAE Richter and Richter, 1955

Genus PERISCHOCLONUS Raymond, 1925

PERISCHOCLONUS CAPITALIS Raymond, 1925

Plate 22; Plate 35, figures 10, 11; Plate 36, figures 5, 7, 8

Raymond, 1925, pp. 159-160, pl. 10, fig. 13.

Holotype. YPM 13049, incomplete cephalon (Pl. 22, figs. 1, 3, 5).

Description. Glabella narrowest across lateral furrows 1p, slightly wider across occipital ring, considerably wider across anterior lobe, moderately convex and slightly overhanging anterior border. Occipital ring curves gently posteriorly; occipital furrow transverse, broad and deep, ending distally in a narrower, deeper constriction; transverse anterior margin of furrow is a steep slope bounding the remainder of the glabella. Lateral glabellar furrow 1p V-shaped, consisting of a deep pit, situated just inside the axial furrow, from which a short, deeper branch runs forward and inwards, and a shallower branch of similar length runs back for a short distance. Narrow (tr.) lateral lobe 1p with slight independent convexity. Lateral glabellar furrow 2p a shallow depression running transversely and commencing a short distance inside the axial furrow, situated about halfway between the occipital furrow and anterior margin; lateral glabellar furrow 3p a similar shallow depression, suboval in outline, situated closer to the axial furrow and midway between lateral furrow 2p and the anterior margin. Axial furrow narrow and moderately deep, continuous with shallow preglabellar furrow; at junction of these furrows a faint subcircular depression may indicate the position of the anterior pit. Cheek subdivided into a convex inner part and an outer flattened, outwardly-sloping portion which anteriorly is continuous with the preglabellar field; latter also flattened and outward sloping, diminishing in length (exs.) medially almost to disappearance. Posterolaterally the outward-sloping part of the cheek is continued as a broad-based, rapidly-tapering librigenal spine, of length (exs.) about half length (sag.) of cephalon. Posterior border of cheek narrow (exs.), convex, curving back slightly behind outer margin of convex portion of cheek and disappearing as it merges with inner edge of librigenal spine. Inner, posterior corner of convex part of cheek, adjacent to lateral glabellar lobe 1p, is a smooth, crescentic, inward-sloping area

(the lateral muscle impression of Šnajdr, 1960, text-fig. 2); immediately outside the posterior part of this area the posterior border furrow begins as a shallow depression, deepening somewhat outwards and then dying out as it reaches the margin of the convex part of the cheek. Eye lobe relatively large and convex, situated about half way across cheek and in line with lateral glabellar furrow 1p; palpebral lobe a small flattened semicircle, larger part of eye lobe is eye surface and bears relatively large, convex facets arranged in intersecting diagonal lines. Anterior branch of suture curves inward and forward across cheek to reach margin about in line with projection of axial furrow. The two branches are probably joined by a rostral suture that runs along the sharp, outer edge of the preglabellar field. Doublure of approximately same width as flattened, outward-sloping dorsal portion of cheek, surface convex ventrally and doublure curling up so that inner edge lies close against boundary between inner and outer parts of cheek. Connective suture (Pl. 22, fig. 8) runs straight inward and backward across doublure from point where anterior branch reaches margin; rostral plate is therefore trapezoidal in outline, broad (tr.) and relatively long (sag. and exs.), the surface convex ventrally. Posterior branch of suture curves outward and backward to cross distal portion of border furrow and border where latter begins to curve back distally. External surface, except in furrows and over crescentic area in inner corner of cheek, bearing small, irregularly scattered tubercles; on sloping outer part of cheek short, anastomosing lines run outward and forward between these tubercles; well-spaced terrace lines on doublure. Median tubercle on anterior slope of occipital ring.

Four thoracic segments articulated to an incomplete cephalon (Pl. 35, figs. 10, 11) have the axial rings broken off, except distally, to expose the long (sag.) articulating half rings. Inner part of pleura broad (tr.) and horizontal, narrower outer part bent down at fulcrum, which is in line (exs.) with angulation in posterior border of cephalon. Pleural furrow directed outward and curving back distally, ending at fulcrum; anterior band convex, much narrower (exs.) and less prominent than posterior band. Outer part of pleura blade-like, curving back. Tubercles on inner part of both bands like those on cephalon.

Pygidium which is believed to belong with this cephalon semicircular in outline, moderately convex. Axis extending back to

about three-quarters of the length, moderately convex, articulating furrow curving gently back, six rings outlined by transversely-directed ring furrows which are shallow medially and deeper distally. Posterior portion of axis undivided, post-axial ridge extends to concave border before dying out. Deep trench of axial furrow separates axis from convex inner pleural region, outer part gently sloping and concave distally. Opposite the articulating furrow a shallow groove (the first pleural furrow) runs out close to the anterior margin, curving back and deepening behind the facet. Seven additional pleural furrows traverse the pleural regions, curving slightly, and subradially arranged with the post-axial ridge. Between the furrows are gently convex ribs. Doublure extends in to about half the width, posteriorly reaching to tip of axis, and is convex ventrally so that inner margin lies close to dorsal exoskeleton. External surface except in furrows bearing irregularly-spaced, low tubercles similar to those of the cephalon and thorax; doublure traversed by anastomosing terrace lines subparallel to the margin.

Development. One exoskeleton (Pl. 22, figs. 9-11) may belong to meraspid degree 5, part of the transitory pygidium having been broken off. Glabella expands forward less markedly and is less convex, but well outlined and reaching almost to anterior margin of cephalon. Occipital furrow is well developed, lateral glabellar furrows not discernible. Axial furrow immediately in front of occipital furrow deepened for a short distance; this deepening may represent the lateral muscle impression. Cheek is less strongly divided into inner convex portion and outer flattened portion, there being no sharp change in slope between these portions. Eye lobe is much less prominent, similarly situated, and dorsal branches of the facial suture follow the same course as in larger cephala. Librigenal spine broad-based and directed more strongly outward than in holaspid cephalon. The first five segments following the cephalon are believed to have been freely articulating. Axis is convex, pleurae extend out horizontally and near the tip are gently bent down and pointed. Shallow pleural furrow runs out transversely in the middle of the pleura, and deepens somewhat at the fulcrum. Transitory pygidium subtriangular in outline, axis convex; anterolaterally it may be seen to be divided into at least five pleurae, each pleura being outlined by a broad, shallow pleural furrow and a narrow (exs.), convex, posterior pleural band.

Discussion. In the holotype Raymond was unable to discern

the course of the posterior branch of the suture and so was uncertain of the affinities of this species. The present material shows this branch and many additional features of the exoskeleton. *Perischoclonus* is remarkably like species of *Bronteopsis* (Whittington, 1950b, pp. 544-546, pl. 71, figs. 9-12, text-fig. 4; Skjeseth, 1955, pp. 15-20, pl. 5, figs. 1-7, text-fig. 1), differing from them in the strong convexity of the glabella and inner part of the cheeks and the consequent depth of the furrows, and the tuberculate external surface. *B. holtedahli* Skjeseth, 1955, is from beds of approximately Llanvirn age in Norway and Sweden, and other species are from younger Ordovician rocks.

The meraspid *Perischoclonus* (Pl. 22, figs. 9-11) has a cephalon like that of *Stygina* (Whittington, 1950b, pp. 547-549, pl. 72, figs. 1-6, 9; Skjeseth, 1955, pp. 12-14, pls. 1-3) and also the meraspid *Kosovopeltis* (Šnajdr, 1960, pl. 3, figs. 6-8). The pleural regions of the transitory pygidium are crossed by pleural furrows and convex posterior pleural bands. These features suggest that in the holaspid pygidium the furrows on the pleural region are pleural furrows, and that the ribs between them correspond in the main to posterior pleural bands. It is quite clear, since axial rings are present, that each rib belongs to a separate pleura, as in scutelluids (Richter and Richter, 1956; Šnajdr, 1960, pp. 233-235).

Bronteopsis and *Stygina* (and allied genera) have been placed in the Styginidae (Skjeseth, 1955; Whittington, *in* Moore, 1959, pp. 0 365-0 367), but it is clear, as Skjeseth also admitted (1955, p. 12), that the boundary between Styginidae and Scutelluidae is tenuous. I prefer to merge the two families and to regard the genera referred to here, together with *Eobronteus* and *Protobronteus* (Sinclair, 1949; Šnajdr, 1960), as early members of the Scutelluidae. Characters of scutelluids have recently been reviewed by Šnajdr (1960) and familial characters exhibited by *Perischoclonus* are as follows: the presence of three pairs of glabellar furrows, the furrows 1p having two divergent branches as in *Bronteopsis;* the forwardly expanding glabella; the narrow, flat preglabellar field; the flattened outer part of the cheeks; the lateral muscle impression in the inner corner of the cheek; the position of the eye lobes; the course of the sutures and shape of rostral plate; the radial arrangement of the pleural ribs and the presence of a post-axial ridge. The probability that scutelluids and illaenids are related has frequently been mentioned. The meraspid *Perischoclonus* is quite like meraspid

Illaenus (compare Plate 22, figure 10 with Plate 20, figures 1, 4) and this may be taken as further evidence of relationship between the two families.

Family CHEIRURIDAE Hawle and Corda, 1847

Subfamily CHEIRURINAE Hawle and Corda, 1847

Genus LEHUA Barton, 1916

LEHUA ARGUS n. sp.

Plate 23, figures 1-4, 6, 8, 9, 11; ? 5, 7

Holotype. GSC 16255, incomplete cephalon, length (sag.) 5.2 mm. (Pl. 23, figs. 1, 2, 4).

Description. Glabella straight-sided, expanding gradually forward to maximum width across lateral lobes 3p, in front of this point rounded. Occipital and lateral glabellar furrows deepest adjacent to axial furrow, lateral furrows spaced equally from each other and the occipital, all directed inward and slightly backward, 1p most strongly back, 2p almost transverse. Lateral lobe 1p has independent convexity and is separated from the median lobe by a broad shallow furrow, lateral lobes 2p and 3p have a faint independent convexity but merge proximally into the median lobe. Cephalic borders convex, defined by deep furrows; narrowest is the anterior border, separated by a shallow preglabellar furrow from the vertical slope of the anterior glabellar lobe; wider are the posterolateral borders which are continued back by a short fixigenal spine. Eye lobe situated on the outer, anterior slope of the cheek, in a transverse line with lateral lobe 3p, continued by a broad eye ridge to the axial furrow; only a narrow band separates eye lobe and eye ridge from the border furrow (Pl. 23, figs. 1, 6). Deep palpebral furrow continuous with furrow along inner margin of eye ridge. Eye surface covers outer side of eye lobe, and is divided into diagonal rows of minute facets (Pl. 23, fig. 11). Posterior branch of suture curves outward and back so that at the crest of the lateral border it is in line with the outer end of lateral glabellar furrow 2p (Pl. 23, fig. 9). Anterior branch of suture runs inward and forward on to outer edge of border, then along border to join rostral suture. Latter commences a short distance inside projected line of axial furrow and runs along outer, upper edge of anterior border; connective sutures converge backward. Rostrum is thus wide (tr.) but short (sag. and exs.), and hypostomal

suture subparallel to rostral suture. Hypostome unknown. External surface of glabella and cheek (including eye ridge and borders) bearing irregularly scattered tubercles. Cheek inside borders closely pitted so that surface is an irregular raised network of ridges, scattered tubercles on these ridges.

Thorax unknown.

Pygidium not known with certainty, but the original of Plate 23, figures 5, 7, may belong here. Axis of two rings, the second lower and narrower (tr.) than the first. Inner parts of pleural region narrow, outer parts consisting of two pairs of long spines. On the inner, anterior part of the first pleura is a conical eminence, presumably the convex anterior band of this pleura. External surface tuberculate. The pygidium is like that of the type species *L. vincula* (Prantl and Přibyl, 1947, p. 19, pl. 3, figs. 1, 2) but includes one less segment, i.e. has two rather than three pairs of border spines.

Discussion. The originals of *Lehua vincula* (Barrande, 1872), type species of *Lehua,* are figured here (Pl. 23, figs. 10, 12), the cranidium being selected as lectotype. The complete thorax and pygidium were described by Prantl and Přibyl (1947, pl. 3, figs. 1, 2; pl. 5, fig. 7). The date of Barton's erection of *Lehua* is 1916, not 1915 as given by Prantl and Přibyl and in Moore, 1959 (see Raymond, 1925, p. 143). *L. argus* shows the nature and position of the eye lobe and eye ridge, and the small size of the free cheek. In other respects the cranidium is extremely like that of the Bohemian species *L. vincula,* and they are of about the same age. *L. vincula* evidently has a small free cheek, and if the eye lobe is present it must be farther forward and inward than that of *L. argus.*

The material on which Billings (1865, p. 286) based *"Cheirurus" polydorus* includes an incomplete cranidium (Pl. 25, fig. 10) and fragments of three glabellas (GSC 675a, b, c), all from "Division P, Portland Creek." Possibly this locality implies that the specimens came from the Table Head Formation and both Raymond (1925, p. 143) and Kindle and I have identified specimens from the type section at Table Point. In outline of the glabella, curvature of the lateral furrows, and position of the eye ridge (running inward and backward from the axial furrow close to lateral glabellar lobe 3p), the holotype of *"C." polydorus* differs from *L. argus;* both Raymond's and our specimens show that the palpebral lobe is opposite lateral glabellar lobe 2p. The genus to which *"C." polydorus* may belong is uncertain, and I intend to discuss this when describing the Table Head

trilobites. A cranidium of length (sag.) *c.* 14 mm., from a white limestone like that at Lower Head, collected by A. Hyatt and labelled as from Cow Head (MCZ 5566), was placed by Raymond in "*C.*" *polydorus* but appears to be *L. argus*.

An additional species placed in *Lehua* is known from the Upper Ordovician of South Wales (Reed, 1908, pp. 433-434, pl. 14, figs. 1-3) and another doubtfully placed here from supposed Silurian rocks in Burma (Reed, 1906, pp. 136-137, pl. 7, fig. 24). Mention of *Lehua* occurring in the "Ordovician of South Africa" is in error (Barton, 1916, p. 129; repeated by Henningsmoen, *in* Moore, 1959, p. 433).

Subfamily HELIOMERINAE Evitt, 1951

Discussion. The heliomerinid material occurring at Lower Head is here divided into two new species, examples of each showing a range in size, those of *Heliomera albata* n. sp. ranging up to a much larger size than those of *Heliomeroides alacer* n. sp. The differences between the larger specimens (compare Pl. 24, figs. 1-7 with Pl. 25, figs. 1, 2, 4, 6) — especially in the division, or lack of it, between median and lateral glabellar lobes — are readily recognisable. The smallest specimens of the two species are extremely similar but not identical (compare Pl. 24, figs. 10, 13, and 14-16). It seems clear that these two species are closely related. Following Evitt (1951), however, it seems that each species should be placed in a separate genus. Until more complete topotype material of *Heliomera sol,* the type species of the genus, is available the distinguishing characters of this genus will remain uncertain.

An isolated pygidium (Plate 25, figure 3) in the present material may be a heliomerinid. It is like that of *Heliomeroides* (Evitt, 1951, pl. 87, figs. 1-4) but includes three segments, and the pleurae become separate only distally where they are continued as hollow spines. If, for example, this pygidium proved to be that of *Heliomera*, it would serve further to distinguish that genus from *Heliomeroides.* For the present these two genera are regarded as distinct but closely related, and retained in the subfamily erected for them by Evitt.

Genus HELIOMERA Raymond, 1905

HELIOMERA ALBATA n. sp.

Plate 24, figures 1-13

Holotype. GSC 16259, incomplete cephalon lacking exoskeleton (Pl. 24, figs. 2, 3, 6).

Description. Glabella suboval in outline, wider than long, greatest width across lateral glabellar lobes 1p. Occipital ring considerably narrower (tr.) than glabella across lateral lobes 1p, occipital furrow bow-shaped in outline, approximately constant in depth. Three pairs of lateral glabellar furrows, 1p deep, running in a curve convex forward and extending inward to more than one-third the width; 2p running at first inward and forward from the axial furrow then curving quite sharply to run inward and backward to about the same distance inward as 1p; 3p shorter, straight, running inward and backward from the preglabellar furrow. Lateral glabellar lobes moderately convex; because of the course of lateral furrows 2p and 3p lateral lobe 3p is markedly L-shaped, the horizontal part of the "L" (or reversed "L") lying outside and in front of the anterolateral portion of lobe 2p. Inward the lateral lobes merge into the median lobe, width (tr.) of this lobe less than that of lateral lobes; median lobe extends forward into short (sag.), broader frontal lobe. In anterior view, anterior border and preglabellar furrow run in course forming an inverted "V," there being a slight depression in the margin of the frontal lobe in the midline. Only posterior part of fixed cheek known, narrow (tr.) and steeply sloping, separated by border furrows from broad, convex, posterior and lateral borders; at genal angle these borders are extended into the fixigenal spine, which is broad at the base, length unknown. External surface granulate. Remaining parts of cephalon unknown in larger specimens.

The smallest cranidium described above is of length (sag.) approximately 5.9 mm. Of three additional cephala, two are of length (sag.) about 1.3 mm. (Pl. 24, figs. 8, 9, 11, 12), one of length 1.7 mm. (Pl. 24, figs. 10, 13). Glabella differs from that of larger cranidia in that the lateral glabellar lobes are more strongly convex, especially 1p which overhangs the axial furrow. Median glabellar lobe is separated from the lateral lobes by a shallow longitudinal depression connecting the inner ends of the lateral glabellar furrows, this depression being most evident posteriorly. The "L" shape of lateral glabellar lobe 3p is less evident, especially in the smaller specimens. In the latter the inverted "V" outline of the course of the preglabellar furrow in anterior view is less pronounced. In one small cephalon (Pl. 24, fig. 8) the right cheek is poorly preserved, semicircular in outline and with a broad border; eye lobe situated opposite outer end of lateral glabellar furrow 2p, connected by stout

sutural ridge to anterior border. The genal spine is long and slim.

External surface of glabella bearing closely spaced tubercles, which are relatively larger in small specimens. Cheek and border also tuberculate, there being a row of well-spaced tubercles on the lateral border.

Discussion. A more complete specimen of the glabella of *Heliomera sol* (Billings, 1865) than the lectotype (Evitt, 1951, pp. 603-605, pl. 85, figs. 24-29) has been collected from the middle part of the Table Head Formation at Table Point Cove. It is of about the same size as the holotype of *H. albata,* and shows that the two species are different. In *H. sol* the glabella is less inflated so that the transverse, and particularly the longitudinal, profiles are less curved and do not slope so steeply. Lateral glabellar furrow 1p is straight and transversely directed, furrow 2p gently curved. Hence the outlines of the lateral glabellar lobes in *H. sol* are different, and lobe 3p does not have the marked "L" shape (Pl. 24, figs. 5, 6) of *H. albata.*

The small cephala of *H. albata* differ from those referred to *Heliomeroides* (compare Pl. 24, figs. 10, 13, with Pl. 24, figs. 14-16) in the outline and convexity of parts of the glabella, particularly the lateral lobes. The frontal lobe is narrower and less prominent, the anterior margin having a gently curved, rather than transverse, outline, the median lobe of the glabella is separated from the lateral lobe by a shallower less marked depression. It is notable that in the development of *Heliomeroides teres* (Evitt, 1951, p. 599) the longitudinal furrow separating the median from the lateral glabellar lobes is deeper in small cephala than in larger cephala; apparently in the development of *Heliomera albata* a shallow longitudinal furrow is present in small cephala but absent in larger cephala.

Genus HELIOMEROIDES Evitt, 1951

HELIOMEROIDES ALACER n. sp.

Plate 24, figures 14-16; Plate 25, figures 1, 2, 4-6

Holotype. GSC 16263, a cephalon (Pl. 25, figs. 1, 2, 4-6) of length (sag.) 3.1 mm.; maximum width of glabella across lateral lobes 1p is 5.1 mm.

Description. Cephalon typical of *Heliomeroides* (Evitt, 1951, pp. 593-602, pl. 85, figs. 1-23). Lateral glabellar lobes strongly convex, distally overhanging the axial furrow. Median glabellar

lobe gently convex, most strongly so adjacent to occipital ring, separated from lateral glabellar lobes by broad, shallow depression. Frontal glabellar lobe displaying shallow median depression adjacent to preglabellar furrow, in this depression a sagittal line of three tiny pits (Pl. 25, fig. 6). Cheek steeply sloping, subsemicircular in outline, broad, gently convex border which anteriorly curves upward and forward to meet narrower, projecting anterior border. Large eye lobe situated opposite outer end of lateral glabellar furrow 2p, eye surface displaying minute facets (Pl. 25, fig. 5), some of which are preserved as pits. Posterior border of cheek prolonged upwards and backwards as base of long, slim fixigenal spine. Anterior branch of facial suture (Pl. 25, fig. 6) runs straight inward and forward to outer edge of anterior border, here it joins at an oblique angle the rostral suture. Across cheek and border anterior branch of suture running along crest of sutural ridge, which ridge merges into the anterior border. Posterior branch of suture (Pl. 25, figs. 4, 6) curving outward and backward to cross border immediately outside base of genal spine; posterior branch runs across cheek on a faint sutural ridge. The smallest cephalon (Pl. 24, figs. 14-16) is similar in size to the smallest cephalon of *H. teres* Evitt (1951, pl. 86, figs. 2a, 2b). As in Evitt's specimen the median glabellar lobe is better defined than in larger examples, however the maximum width of the glabella is across the basal lobes (not across lateral lobes 2p) and the sagittal profile is similar to that of larger examples. The distal parts of the frontal glabellar lobe have a quite marked convexity. On the posterior margin of the occipital ring there is a suggestion of a median tubercle.

While *H. alacer* displays characters typical of *Heliomeroides,* it differs from the type species in that the eye lobe is situated much farther forward and the genal spine is long and slim — in these respects the diagnosis given by Evitt (1951, p. 593) requires modification.

Subfamily SPHAEREXOCHINAE Öpik, 1937

Discussion. Examination of Plate 25, figures 7-9, 11, 12, Plates 26 to 30, Plate 31, figures 1-17, 19, 20, and Plate 36, figures 1-4, 6, will show the nine species and five indeterminable species (based on nine distinct kinds of cephala and six kinds of pygidia) that are included under this heading. More than 300 specimens are available, but only one is an entire exoskeleton.

Generic and higher classification of cheirurids, however (cf. Henningsmoen *in* Moore, 1959, pp. 0 431-0 439), is largely dependent on characters of thorax and pygidium, isolated cephala being difficult to place. The present material raises many problems, and my solution for them is not unique.

Billings (1865, pp. 284-286) named three of the species, one based on an isolated cephalon and an isolated pygidium, the other two on isolated cephala. The first of these, *K. vulcanus,* is the type of *Kawina* Barton, 1916, and I have here selected the cephalon as lectotype. No complete exoskeleton has been found, so whether or not the pygidium belongs in the type species is unknown. Two additional species, each having a cephalon like that of *K. vulcanus,* are placed in *Kawina.* The entire exoskeleton belongs to one of these species. The six remaining species, two of them named by Billings, have sufficiently similar cephala to be considered as belonging within one genus for which the new name *Cydonocephalus* is proposed below. The thorax of this new genus is incompletely known, the pygidium unknown; it appears to be closely related to *Kawina.*

The thoracic segments of *Kawina* and the new genus lack the pleural furrow or row of pits, and the broad, flattened outer parts of the pleurae are bluntly terminated and facetted, not spinose. Hence they cannot be included in the subfamily Cyrtometopinae (Öpik, 1937, pp. 89-90; Henningsmoen, *in* Moore, pp. 0 433-0 434) where *Kawina* was originally placed. Öpik (1937, p. 91) characterised the subfamily Sphaerexochinae as including only the type genus which lacked pleural furrows. Because of this and other characters (discussed below) shared by *Kawina, Cydonocephalus,* n. gen., and *Sphaerexochus* I have placed them in this subfamily.

Genus KAWINA Barton, 1916

Type species. Cheirurus vulcanus Billings, 1865.

Diagnosis. Convex glabella of maximum width across lateral lobes 1p, this width two-thirds that of cephalon, cheek steeply sloping. Three pairs of lateral glabellar furrows, 1p longest, S-shaped, not reaching occipital furrow. May be low hump in glabella in front of occipital furrow, when hump is present occipital furrow is indented medially. Eye lobe situated close to axial furrow and opposite outer end of furrow 1p. Rostral plate and hypostome of *Sphaerexochus* type. Thorax of 12 segments,

pleurae without furrow and curved steeply down, broadly facetted. Pygidium including three axial rings and a terminal portion, three pairs of pleurae curved back and fused, only blunt point is free; doublure wide.

Discussion. Only the cephalon (lacking the hypostome) of the type species is known, and the above diagnosis is based on the assumption that *K. arnoldi* n. sp., of which the entire exoskeleton has been found, is correctly placed in this genus.

The pleurae of *Kawina* are unusual among cheirurids (including *Sphaerexochus*) in that the outer parts are broad and flattened and hence overlap when the thorax is enrolled, and in that they are fused along almost the entire length in the pygidium. A relation between *Kawina* and *Sphaerexochus* (Whittington and Evitt, 1954, pp. 87-95, figs. 24-27, pls. 20, 32, 33) is suggested, however, by the similarity in form of the cephalon in the two genera, including the presence of three pairs of lateral glabellar furrows, and lack of pleural furrow. *Sphaerexochus* does not exhibit the posteromedian hump on the glabella, furrow 1p is not S-shaped but curves evenly inward and backward to the occipital furrow to isolate a rounded lobe 1p, and there are ten thoracic segments having the outer parts of the pleurae in the form of thick, rounded spines. Differences between *Kawina, Sphaerexochus* and *Cydonocephalus* n. gen. are discussed under the latter genus.

Kawina vulcanus (Billings, 1865)

Plate 25, figures 7, 8; Plate 26, figures 1-3, 13; Plate 28, figures 16-19

Billings, 1865, p. 284, figs. 271a, b, ? not 271c.

Lectotype (here selected). GSC 669, incomplete cranidium, original of Billings, 1865, p. 284, fig. 271a, from "Division P, Cow Head." The type material includes also the cranidium GSC 669c, here referred to *K. limbata* n. sp.; 669a, a fragment of a glabella, and 669b, a pygidium discussed below. An original of Billings' figure 271b of the cephalon was not recognised.

Description. The strongly convex glabella is widest (tr.) across the basal lateral glabellar lobes, this width slightly greater than the length (sag.); greatest height of glabella at posterior portion of median lobe, so that this lobe slopes steeply back to the occipital furrow; lateral view (Pl. 25, fig. 8) shows that a large portion of the glabella overhangs the anterior border. Occipital furrow narrow, deep, outline bow-shaped, the median portion

running behind the swollen median lobe in a curve concave forward. Lateral glabellar furrows narrow and deep, 1p "S" shaped and the longest, the inner portion curving inward and backward and dying out some distance from the occipital furrow; median lobe between inner ends of furrows 1p of about the same width (tr.) as lateral lobes 1p. Lateral glabellar furrows 2p and 3p shallower and shorter, evenly curved and spaced so that the lateral glabellar lobes are successively shorter (exs.). Axial furrow narrow and shallow, shallow pit at anterior extremity; preglabellar furrow broader and deeper. Anterior border in front of preglabellar furrow extremely narrow (sag. and exs.). Subtriangular cheek (Pl. 26, figs. 1-3) steeply sloping, broad, deep border furrow, sharply ridged lateral border, the edge of which descends steeply and curves underneath to form the doublure; posterior border narrowest (exs.) adjacent to axial furrow, widening distally, defined by narrow posterior border furrow. Eye lobe small, situated close to axial furrow and opposite most anterior and outer part of lateral glabellar lobe 1p. Anterior branch of suture runs forward a short distance outside of, and parallel to, axial furrow, crosses border furrow on a faint sutural ridge and runs on to outermost edge of border where it joins the rostral suture. Posterior branch of the suture runs at first outward subparallel to the posterior border furrow then curves around through about 90° to cross the outermost portion of the posterior border; immediately inside the suture the posterior border is broadest (exs.), much broader than is the border outside this branch of the suture (Pl. 26, fig. 2). Connective suture (Pl. 26, fig. 13) runs inward and backward, continuing the projected line of the axial furrow; rostral plate broad but extremely short (sag. and exs.). External surface, except in furrows and on lateral and anterior borders, bearing scattered tubercles of varying size.

Kawina limbata n. sp.

Plate 25, figures 9, 11, 12; Plate 26, figures 4-6, 10

Holotype. GSC 16267, incomplete cephalon.

Other material. GSC 669a, cranidium included in the type lot of *K. vulcanus;* GSC 668b, incomplete cephalon included in the same lot as the type specimens of *"Cheirurus" mercurius* Billings, 1865, both from "Division P, Cow Head."

Description. Cephala included under this name differ from *K. vulcanus* (compare Pl. 25, figs. 7, 8, with 9, 11, 12; Pl. 26,

figs. 1-3, 13 with 4-6, 10) in convexity of particular areas, which may best be compared in lateral and anterior views. The posteromedian portion of the glabella lacks the marked swelling and so does not display the "hump" in longitudinal profile. In anterior view the glabella is less strongly and evenly arched, the sides of the median portion sloping more gently, though the distal parts, and particularly the distal parts of lateral glabellar lobes 1p and 2p, descend steeply and 1p overhangs the axial furrow. The cheek slopes more steeply distally than that of *K. vulcanus*. The outer surface of the lateral cephalic border is considerably wider. The differences in convexity and slope of different parts of the cephala are reflected also in the ventral view — the obtuse angle between the inner margin of the rostral plate and the cheek doublure is larger in *K. vulcanus* than in *K. limbata*.

The cephala of *K. limbata* range in length (sag.) from 8 to 13 mm., and those of *K. vulcanus* from 5 to 17 mm., thus the differences between these two cephala can be observed in medium and relatively large-sized individuals, but not in small ones. External surface bearing scattered, prominent tubercles (Pl. 25, figs. 9, 11, 12). In specimens from which most of the exoskeleton is stripped off, furrows appear deeper and broader and the tubercles are far less prominent (Pl. 26, figs. 4-6). Some specimens suggest that the surface between the tubercles is covered by an extremely fine granulation.

Kawina arnoldi n. sp.

Plate 26, figures 7-9, 11, 12, 14; Plate 27, figures 1, 2, 4-6, 8, 9

Holotype. GSC 16268, enrolled exoskeleton.

Description. Cephalon differs from those of *Kawina vulcanus* and *K. limbata* n. sp. (compare Pl. 26, figs 7-9 with 1-3 and 4-6, respectively) in that occipital furrow is straight, eye lobe is larger and situated farther forward, and the posterior border furrow joins the axial furrow at a point considerably behind the junction of the axial and the occipital furrows. In general form and convexity, particularly of the glabella, *K. arnoldi* is most like *K. vulcanus*, except that there is no inflation of the posteromedian part of the glabella and the amount of forward bulging is less. The glabella thus differs from that of *K. limbata* in that the median part of the glabella is more convex and the distal parts not inflated and descending less steeply to the axial furrow. The lateral cephalic border is most like that of

K. limbata, and the lateral border furrow narrow and deep. Posterior branch of facial suture curves outward and backward from eye lobe to cross outer part of posterior border; inside this suture the posterior border is much wider (exs.) than the border immediately outside the suture; thus the posterior border forms a blunt tongue-like projection beyond the rest of the cephalon, the outer parts of the thoracic pleurae fitting beneath this projection during enrollment.

Middle body of hypostome (Pl. 27, figs. 1, 4) longer than wide, sub-divided by short middle furrows into a large anterior and small posterior lobe, the latter of equal width (tr.) to the anterior lobe. Shallow anterior border furrow and extremely narrow anterior border which follow the convex curve of the anterior margin of the middle body; lateral and posterior borders broader, shoulder a sharp projection directed downward and outward. Small anterior wings directed upward and outward. Posterior border with a shallow median sulcus in the margin. Rostral plate narrow (sag. and exs.), anterior and posterior margins strongly curved convexly forward, lateral margin (the connective suture) lies approximately in the line of the continuation of the axial furrow.

Thorax of 12 segments, broad, gently convex axis narrowing backward, inner parts of pleurae sloping outward, outer parts curved down, extremities vertical. Surface of axial ring flat, ring furrow narrow and deep. Axial furrow shallow. Inner part of pleura narrow (tr.) and without pleural furrow. Outer parts of pleurae about three times as wide (tr.), broadly facetted. Doublure extending inward to inner margin of outer parts of pleurae.

Pygidium with axis triangular in outline, divided into three rings and a triangular posterior portion. First ring furrow transverse, second and third ring furrows bow-shaped, the median portion curving convexly backward, more strongly in the third ring furrow than the second. Pleural regions divided by interpleural furrows that curve outward and strongly backward, the third pair of pleurae lying side by side and extending directly back behind the posterior portion of the axis. Doublure broad, extending inward laterally close to the margin of the axis, posteriorly extending beneath posterior portion of axis where inner edge is upturned vertically.

External surface except in furrows bearing close-spaced, low tubercles.

Discussion. Length of cephala (sag.) ranges from 3 to 10 mm., that of the holotype being 4.7 mm. Smaller specimens than those of either *Kawina vulcanus* or *K. limbata* are known, but no specimens as large as the largest of the other two species. The known ranges in size of all three species overlap sufficiently, however, that specimens of the same size may be compared and no transitions between the species seem to exist.

? Kawina sp. ind.

Plate 31, figures 1-3, 6, 7

Cheirurus vulcanus Billings, 1865, p. 284, fig. 271c.

Description. Axis of pygidium of three rings and a small terminal piece, length about equal to width (tr.), differing from that of *Kawina arnoldi* n. sp. (Pl. 26, figs. 8, 12, 14; Pl. 27, figs. 2, 5, 6, 8, 9) in that ring furrows are gently curved, posterior portion of axis is relatively smaller, and axis tapers more rapidly posteriorly. Pleural regions consisting of three fused pairs of pleurae separated by interpleural furrows, first and second interpleural furrows commence opposite junction with axial furrow of corresponding ring furrow. Inner part of pleural region flattened, outer part curved gently downward so that this region is less strongly convex than that of *K. arnoldi.* External surface bearing scattered, medium-sized and small tubercles.

Thoracic segments articulated with this pygidium have flattened, gently convex axial rings, pleurae lacking pleural furrow, of about constant width (exs.) and in contact with one another almost to the tip; pleurae curved gently down distally.

Pygidium gen. ind. 1

Plate 31, figures 4, 5, 8, 9

Description. This, the most abundant sphaerexochinid pygidium in the present material, is characterized by the relatively short (sag.) triangular axis divided into three rings. Median part of articulating and ring furrows curves convexly backward so that these furrows have a bow-shaped outline. Pleural regions gently convex and moderately steeply sloping, gently convex pleurae separated by broad, deep interpleural furrows. First interpleural furrow commences opposite junction of axial and first ring furrow. Second interpleural furrow leaves axial furrow opposite posterolateral angle of third axial ring. Inner

pair of pleurae the narrowest (tr.), running back from the posterior margin of the third axial ring, which has a V-shaped outline. External surface bearing scattered low tubercles and granules which are most conspicuous along the sides of the interpleural furrows and along the inner margin of the facet. Thoracic segments are curved quite strongly backward, the inner part narrow (tr.), the outer part long and steep, terminating in a backwardly-directed point. Doublure extends in to fulcrum. Row of tubercles and granules runs along inner edge of broad facet.

Pygidium gen. ind. 2
Plate 31, figures 10-12, 15, 16

Description. This pygidium has proportions and outline similar to those of *Kawina* ? sp. ind. — the axis consists of three rings and a small terminal portion; the interpleural furrows commence opposite the corresponding ring furrows. Distinctive are the falcate pleurae, the curved, pointed tips free distally, contrasting with the spatulate, blunt-ended pleurae of *Kawina* ? sp. ind. Posteriorly axis becomes vaguely defined, and posterior band of second and third pleurae tends to merge into the axis. Not only are the pleurae falcate in outline, but they are divided into a convex posterior band (this being broadest proximally) and a flattened or concave anterior band. At approximately half the width (tr.) of the pleurae the tip becomes free, and where tips of adjoining pleurae separate there is a shallow circular depression. Doublure extends in beyond these depressions. Convexity of pleural regions low. External surface bearing scattered tubercles.

Thoracic segments correspondingly have falcate, backwardly curved pleurae, the external surface of which bears scattered tubercles.

Pygidium gen. ind. 3
Plate 31, figures 13, 14, 17

Description. This pygidium resembles that of gen. ind. 2 in its general proportions, but is distinguished by the narrow-appearing, not falcate but parallel-sided, convex pleurae which slope more steeply backward, and by the relatively much coarser tubercles on the external surface. Outer part of each pleura free beyond about half the width (exs.), the tip bluntly pointed

Articulated thoracic segments show similar pleurae, the outer parts bent to slope steeply, external surface of both axial rings and pleurae bearing coarse tubercles.

Pygidium gen. ind. 4
Plate 31, figures 19, 20

Description. This pygidium is extremely like that of gen. ind. 2, in both the outline and definition of the axis as well as the falcate form of the pleurae. Comparison of thoracic segments and pygidium with those of gen. ind. 2 shows that the axis is more convex and the pleural regions are more steeply bent down laterally and slope more steeply posteriorly. External surface bears scattered small and medium-sized tubercles, particularly conspicuous on the outer parts of the pleurae. Gen. ind. 4 is also very much like gen. ind. 3 but the coarse tuberculation of the latter distinguishes it.

Four isolated pygidia are tentatively assigned to gen. ind. 4, and suggest that it may be distinguished from gen. ind. 2 by the slightly longer (sag.), triangular, terminal portion of the axis.

Cydonocephalus n. gen.

Type species. Cydonocephalus griphus n. gen., n. sp.

Diagnosis. Differs from *Kawina* in that glabella is most convex anteriorly (not posteromedially) and juts forward, lobe 1p, and in some species 2p and 3p, are gently inflated, and occipital furrow curves forward (not back) medially. Thoracic segments like those of *Kawina,* pygidium unknown. Differs from *Sphaerexochus* in that furrow 1p is S-shaped and does not reach occipital furrow, glabella may be elongate and crossed by depression joining inner ends of furrows 1p, and outer parts of thoracic pleurae are flattened and broadly facetted.

Discussion. The six species included in this genus show a wider range of form of the glabella and cheek (depth and width of border furrow, form of border) than is exhibited by species of *Sphaerexochus* or *Kawina,* yet not, as indicated in the diagnosis, the combination of characters exhibited by either of these genera. The general form of the cephalon, including rostral plate, hypostome and course of sutures, is so alike in all three genera as to suggest relationship. *Sphaerexochus* is so far known only from younger rocks of the Marmor and succeeding stages in

North America, and so may be derived from either of the other genera. It seems likely that some of the isolated types of thorax and pygidium described above (Pl. 31, figs. 4, 5, 8-17, 19, 20) may belong to species of *Cydonocephalus*. If so, the resemblance of this genus to *Kawina* would be greater than that to *Sphaerexochus*.

Cyrtometopinids such as species referred to *Pseudosphaerexochus* (e.g. Warburg, 1925, pl. 10, figs. 1-25) or *Pateraspis* (Prantl and Přibyl, 1947, pl. 3, figs. 11, 12) have cephala like those here referred to *Cydonocephalus*. However, in both these genera the glabella is more ovate in outline, the posterior branch of the suture crosses the lateral rather than outer posterior border, the inner part of the pleurae display a median row of pits, and the pygidium with its free pleural spines is unlike any found in the present material. *Pompeckia* Warburg (1925, pp. 370-377, pl. 9, figs. 23-38) is another genus the cephalon (including the hypostome) of which is very like that of *Cydonocephalus*, but the peculiar pygidium has not been recognized from Lower Head. *Stubbleficldia* (Prantl and Přibyl, 1947, pp. 32-34, pl. 3, figs. 14, 15) is an Upper Ordovician genus from Bohemia having a similar type of cephalon, though the cheeks are broader and the outline of the glabella oval, but the characteristic type of pygidium is not known to occur at Lower Head. It is because of these various differences, and particularly because the thorax of *C. griphus* is not like that of *Sphaerexochus*, and partly because of the lack of complete exoskeletons, that I prefer to make a separate genus for the reception of these six species.

Cydonocephalus griphus n. sp.

Plate 27, figures 3, 7, 10-15, 19; Plate 28, figures 1-4

Holotype. GSC 16272, cephalon with hypostome.

Description. Glabella in dorsal aspect subcircular in outline, only slightly wider than long (sag.), in lateral profile semicircular in shape. Occipital furrow narrow and deep, bow shaped in outline, the median portion behind the median lobe directed transversely; occipital ring narrowest (exs.) distally. Remainder of glabella inflated so that it rises steeply from the occipital ring and slightly overhangs the axial furrow, lateral furrow 1p "S" shaped, extending inward more than one-third the width of the glabella, lateral glabellar lobe 1p displaying slight independent convexity. Lateral glabellar furrows 2p and 3p originating close together and about midway between the

preglabellar furrow and the outer end of lateral furrow 1p, diverging as they run inward and upward onto the glabella, furrow 3p more strongly curved than 2p; both furrows narrower and shallower than lateral furrow 1p. Preglabellar furrow shallowest medially, anterior border narrow and sharply ridged; in axial furrow just in front of lateral glabellar furrow 3p an anterior pit. Cheek subsemicircular in outline, convex and descending almost vertically from the axial furrow. Lateral border defined by a deep border furrow of about the same width; inner edge of lateral border (Pl. 27, figs. 7, 14) bearing a strongly raised ridge, outer part of this border flattened and vertically sloping to the margin where the border curves sharply under to form the doublure (Pl. 27, fig. 19). Convex posterior border defined by narrower posterior border furrow, border widens rapidly distally to a maximum width where the short fixigenal spine projects backward (Pl. 27, fig. 11); immediately outside this spine it is crossed by the posterior branch of the suture and becomes narrower as it curves downward and forward to join the lateral border. Eye lobe small, suboval in outline, situated close to axial furrow and immediately behind intersection of axial furrow and lateral glabellar furrow 1p, eye surface bearing minute facets arranged in diagonal lines. Anterior branch of suture (Pl. 27, fig. 12) runs straight forward, converging toward the axial furrow so that it crosses the border furrow immediately outside this furrow; the branch running on a faint sutural ridge which becomes strong as it crosses the border furrow. Posterior branch of the suture curves around in a roughly quarter-circle arc to cross the posterior border outside its greatest width. Rostral suture runs along the lower margin of the forwardly projecting anterior border, rostral plate broad but short (sag. and exs.), sloping downward and backward, distally defined by a connective suture that runs inward and forward in the projected line of the axial furrow. Hypostome (Pl. 27, figs. 7, 12, 15, 19) with anterior margin a curve convex forward, anterior border developed only distally. Middle body convex, subsquare in outline, defined by furrows which are deepest laterally and posteriorly. Short middle furrow commencing at about half the length, deep, directed inward and backward. Convex outwardly and downwardly pointing shoulder situated opposite middle furrow; lateral border widens posteriorly to merge with the broader, flattened, posterior border, the posterior margin forming an even, backwardly-convex curve.

Anterior wing small; opposite the lateral notch the inner margin of the cephalic border is excavated in a shallower notch (Pl. 27, figs. 12, 19). External surface, excluding furrows and border, covered with rounded, close-spaced tubercles of varying size. Cephala range in size from a length (sag.) of 1.8 mm. to 7 mm., the holotype being one of the smaller specimens but selected because the hypostome is complete. Thorax and pygidium unknown.

Cydonocephalus torulus n. sp.

Plate 27, figures 16-18; Plate 28, figures 5-8; Plate 29, figures 1-7, 9; Plate 36, figures 1-4, 6

Holotype. GSC 16277, cephalon with hypostome.

Description. Cephala ranging in length (sag.) from 2.9 (Pl. 29, figs. 1-3, 6) to 7.5 mm. (Pl. 29, figs. 4, 5, 9) are known, covering much of the range of size seen in *C. griphus*. *C. torulus* differs from *C. griphus* in that the glabella is more convex anteriorly (comparison of lateral views [Pl. 28, figs. 3, 7] shows that glabella bulges forward more and the axial furrow descends more steeply in *C. torulus*) and lateral glabellar lobe 1p is less inflated and does not bulge out posterolaterally over the axial and occipital furrows (compare Pl. 28, figs. 5, 6 with 1, 2); eye lobe is larger and situated slightly further forward, the midpoint opposite the distal end of lateral glabellar furrow 1p; the lateral border furrow and border are similar in the two species except that the ridge along the inner edge of the border is developed only posteriorly in *C. torulus*. Comparing ventral views of *C. torulus* (Pl. 29, fig. 6) and *C. griphus* (Pl. 27, fig. 19) it may be seen that the outline of the anterior border, margins of the rostral plate and anterior margin of the hypostome are all more strongly curved forward in *C. torulus*. Thus the hypostome is relatively longer, the middle body projecting farther in front of the anterior wings, the lateral margins converge more strongly posteriorly and there is a shallow sulcus in the margin of the posterior border. External surface tuberculate, much as in *C. griphus*.

Five thoracic segments are articulated with the smallest cephalon (Pl. 27, figs. 16-18), and three with a slightly larger cephalon (Pl. 36, figs. 1-4, 6). Axial ring convex, articulating furrow deep, straight. Pleurae gently convex (exs.), inner part horizontal, without pleural furrow, outer part as wide (tr.) as inner and bent steeply down and broadly facetted. The anterior

pleura is directed backward and outward behind the posterior cephalic border, beneath which it fits, the genal spine concealing the outer part. Successive pleurae are less strongly backwardly directed. Tip of pleura expands slightly and ends abruptly. Pygidium unknown.

Cydonocephalus scrobiculus n. sp.

Plate 28, figures 9-11; Plate 29, figures 8, 10-15

Holotype. GSC 16280, cephalon lacking hypostome.

Description. Cephala range in length (sag.) from 3.3 mm. (Pl. 29, figs. 12, 13, 15) to 6.5 mm. Distinctive of this species is the outline of the glabella in dorsal aspect (compare Pl. 28, figs. 9-11 with figs. 1-8, 12-15), which is relatively wide at the level of lateral furrows 2p, the anterior part bulging forward to strongly overhang the anterior border; median part of the occipital furrow broad and deep, lateral furrow 1p curves forward distally but the inner part is straight and directed almost transversely, only at the inner extremity does it turn abruptly to be continued back toward the occipital furrow by an extremely shallow longitudinal furrow. The eye lobe is of medium size, smaller than that of *C. torulus,* situated opposite the extremity of lateral glabellar furrow 1p. Lateral border furrow (Pl. 28, fig. 11; Pl. 29, figs. 13, 14) broad and deep, the inner edge rising abruptly to meet the surface of the cheek outside the eye lobe, the outer edge curving upward less steeply to the narrow border which does not have any subsidiary ridge; furrow ending abruptly against the sharp, high sutural ridge on which the anterior branch of the suture runs. Posterior branch crosses the furrow on a much lower sutural ridge. In ventral aspect curvature of anterior border and rostral plate seem to be intermediate between that of *C. griphus* and *C. torulus.* Hypostome unknown. External surface, except in furrows, bearing tubercles of varying size rather more widely spaced than in *C. griphus.*

Thorax and pygidium unknown.

Cydonocephalus prolificus (Billings, 1865)

Plate 28, figures 12-15; Plate 29, figures 16, 17; Plate 30, figures 1-10

Billings, 1865, pp. 285-286, fig. 273.

Holotype. GSC 687, incomplete cephalon, original of Billings' figure 273, from "Division P, Cow Head."

Other material. GSC 687 b-d, f-n, cephala in type lot from same locality studied by Billings.

Description. Cephala ranging in length (sag.) from 1.4 (Pl. 30, figs. 7-9) to 8.0 mm., the holotype being 6 mm. Glabella in dorsal aspect and longitudinal profile most like that of *C. torulus* (compare Pl. 28, figs. 12-15 with 5-8), length and curvature of lateral glabellar furrows and amount of inflation of lateral lobes similar to this same species; the glabella of *C. prolificus* differs from that of *C. torulus* in that the outline in dorsal aspect is more squat and the longitudinal profile more flattened posteriorly. Eye lobe is similar in size but situated further forward, opposite about midlength of lateral glabellar lobe 2p. Fixigenal spine in large cephala (Pl. 29, fig. 16) short and blunt. The curvature of the anterior border and rostral plate in ventral view is less than that of *C. torulus*. The form of the lateral border of the cheek distinguishes this species from all others. Along a line joining the extremities of the two branches of the suture the cheek is flexed down sharply; outside this flexure the border is broad and slopes steeply downward and outward, the margin sharp since the exoskeleton is turned abruptly underneath so that the doublure lies close beneath the border. External surface finely granulate, a few scattered small tubercles, these being most abundant on the cheek and border outside the eye lobe.

Thorax and hypostome unknown.

The smallest cephalon (Pl. 30, figs. 7-9; the smallest known of any species of *Cydonocephalus*) shows the specific characters, though the fixigenal spine is relatively long, and the lateral border gently convex, not flat. At a length (sag.) of about 2.0 mm. (Pl. 30, figs. 4-6) the cephalon differs from larger ones only in the gently convex surface of the lateral border, the longer fixigenal spine, and relatively coarser tuberculation.

Cydonocephalus mercurius (Billings, 1865)

Plate 30, figures 11-13, 19, 20

Billings, 1865, p. 285, fig. 272.

Holotype. GSC 668, incomplete cranidium, original of Billings, figure 272, from "Division P, Cow Head."

Other material. GSC 668f, one of Billings' originals, an incomplete cephalon, from the same locality as the holotype. Other specimens in the type lot, GSC 668 a-e, do not belong here.

Description. No additional material of this species has been

found. The holotype is of length (sag.) 7.0 mm., the other cephalon 5.0 mm. Distinctive of this species (compare Pl. 30, figs. 11-13 with Pl. 28, figs. 1-15) is the inverted U-shaped profile of the glabella in dorsal view, and the deep lateral glabellar furrows 1p, which are united at their inner ends by a shallow, transverse median furrow. The glabella between the occipital furrow and lateral furrows 1p is inflated, especially distally. Lateral glabellar furrows 2p and 3p are shorter, narrower and shallower. Eye lobe relatively large, situated a short distance from the axial furrow and opposite the distal portion of lateral glabellar furrow 1p. Lateral border furrow (Pl. 30, fig. 20) of moderate breadth and depth, nature of lateral border uncertain. Anterior branch of suture crosses border furrow on sharp sutural ridge. External surface, except in furrows, covered with closely-spaced, medium and small-sized tubercles.

Cydonocephalus prominulus n. sp.

Plate 30, figures 14-18, 21

Holotype. GSC 16287, incomplete cephalon lacking the hypostome.

Description. No small cephala are known, the length (sag.) ranging from 6.5 to 12.0 mm.; this range overlaps that of all the other species, however, and enables comparisons with simliar sizes of cephala. This species is like *C. mercurius* (compare Pl. 30, figs. 14-16 with 11-13), but is distinguished at once by the lack of a median furrow connecting the inner ends of lateral glabellar furrows 1p; instead, the inner end of this furrow turns back and dies out; lateral glabellar furrows 2p and 3p are deeper, partly because lateral lobes 2p, 3p and the anterior lobe have a gentle independent convexity. The eye lobe is similar in size and position to that of *C. mercurius,* the lateral border furrow broad and deep, the lateral border moderately convex. In lateral view (Pl. 30, fig. 17) the angle between the anterior and lateral borders is much more oblique than in *C. griphus, C. scrobiculus* and *C. prolificus,* and appears to be greater than that in *C. mercurius.*

Family ODONTOPLEURIDAE Burmeister, 1843

Genus Ceratocephala Warder, 1838

Ceratocephala exigua n. sp.

Plate 31, figures 18, 21; Plate 32, figures 1-3

Holotype. GSC 16298, incomplete cephalon.

Description. The cephalon is like that of such younger species of *Ceratocephala* as *C. laciniata* and *C. triacantheis* Whittington and Evitt, 1954 (pl. 7, figs. 17, 19, 20; pl. 8, figs. 1-3, 7; pl. 25, figs. 12-18) in displaying the three pairs of lateral glabellar lobes, the raised area on the median glabellar lobe in line with the anterior part of lateral lobe 2p, in the position of eye lobe and eye ridge, and presence of the supplementary ridge on free cheek running into base of genal spine. The species is most like *C. laciniata,* the younger of the two described by Evitt and myself. The Newfoundland species is not at all like the cranidium from the middle Chazy limestone described by Raymond (1910, p. 234, pl. 38, fig. 5; pl. 39, fig. 15), nor like the older odontopleurid figured by Hintze (1953, pl. 19, fig. 16).

Family LICHIDAE Hawle and Corda, 1847

Subfamily TETRALICHINAE Phleger, 1936

Apatolichas n. gen.

Type species. Lichas jukesi Billings, 1865.

Diagnosis. Differs from *Amphilichas* (Tripp, 1957, pp. 116-117, text-figs. 4q-r, 5d; *in* Moore, 1959, p. 0 498, figs. 395, 1a-c; 393,6) in that axial furrow is absent from a point opposite midpoint of eye lobe back almost to the occipital furrow; lateral glabellar furrow 1p represented by notch in axial furrow and notch in longitudinal furrow at about mid-length, in inner surface of exoskeleton corresponding ridges longer and stronger, may be weak or absent from mid-part of composite lobe, or continuous across it; occipital lobe having low convexity, may be outlined by faint depression proximally as well as by axial furrow distally; on inner surface of exoskeleton corresponding ridges may partially or completely outline the occipital lobe. Pygidium not having axis extended to posterior margin, but portion behind second axial ring short and blunt; third pleurae also short (exs.); first interpleural furrow present in small pygidia, not in large.

Discussion. The type species has been referred to *Amphilichas* by Tripp (1958, table 1, p. 577), but the original of Billings figure 323b regarded by him (Tripp, 1957, p. 121) as a ceratarginid. There is a considerable difference between the appearance of the holotype (Pl. 32, figs. 4, 5) and similar specimens (Pl. 32, figs. 6-8; Pl. 34, figs. 7, 9, 11), and such other specimens as the

originals of Plate 34, figures 6, 10, which are like GSC 671b, the original of Billings figure 323b. Billings observed these differences (when a larger number of specimens than the original lot became available) and remarked that the cephalon "varies in a remarkable manner" (1865, p. 335). Over 200 cephala have been available to me, and of these most are like the holotype, only a few being of the deeply furrowed type as seen in Plate 34, figure 6. Further, all those of the deeply furrowed type show evidence of partial decortication, and I conclude that these differences in appearance between cephala of the same size are probably in major part the result of splitting off of exoskeletal layers. This decortication reveals the internal mould, and on the inner surface of the exoskeleton the ridges corresponding to furrows on the external surface are strong. Hence furrows on a partly decorticated specimen appear deeper, and some that are faint or absent on the external surface are present on the mould. Superimposed on this is some variation, on both surfaces of the exoskeleton, in the depth and strength of lateral glabellar furrow 1p and furrows defining the occipital lobe. Size is also a factor, since in small cephala (Pl. 34, figs. 1-5) apparently furrows are deeper, and lobes slightly more inflated (the reverse of the case in a size series of *Hemiarges,* Whittington, 1961a, p. 442, pl. 56, figs. 1-4, 6-11, 15, 18, 23, 26, 32, 33). Appearance of difference in depth and development of glabellar furrows between specimens is the only notable type of variation observed in the cephalon, other features being remarkably constant. Specimens of other parts of the exoskeleton do not fall into two types as they might be expected to do if two species of different genera were present. Differences in appearance between furrows on the outer and inner surfaces of the exoskeleton have been observed before in lichids (Warburg, 1939, p. 14; Whittington, 1961a, p. 438), and may be a source of difficulties in taxonomic work.

In the characters of the glabella which distinguish it from species of *Amphilichas, Apatolichas jukesi* approaches species of *Hemiarges* (Tripp, 1954, pl. 1, figs. 14a, 18, 21). The hypostome, however, is of *Amphilichas* type, and the pygidium more like that of *Amphilichas* than that of *Hemiarges* (Tripp, 1954, pl. 1, fig. 23). Tripp (1957, text-fig. 7) suggests that the last two genera mentioned may have a common ancestry, and the present species is, in both its morphology and time of appearance, such a possible common ancestor.

Apatolichas jukesi (Billings, 1865)

Plate 32, figures 4-11; Plates 33, 34; Text-figure 6

Billings, 1865, pp. 282-283, 335, figs. 269a, b, 323a, b.

Holotype. GSC 671a, original of Billings figure 269a, b, from "Division P, Cow Head."

Other material. GSC 671 (possibly original of Billings fig. 323a); 671b, original of Billings figure 323b; 671c-n; all incomplete cephala from same locality and horizon.

Description. Glabella of length (sag.) about equal to maximum width, which is across occipital ring and anterior lobe, glabella narrows slightly between eye lobes; moderately convex transversely between eye lobes, in front of eye lobes strongly convex longitudinally so that anterior lobe overhangs anterior border. Occipital ring wider (sag.) medially than laterally, posterior margin curving gently convexly forward; occipital furrow straight medially, distally curving backward and outward. Lateral glabellar furrow 3p curves inward and is continued by the longitudinal furrow (Pl. 34, fig. 11); opposite the midpoint of the eye lobe there is a change in direction and the longitudinal furrow is continued straight back to join the angle in the occipital furrow; the posterior portion of the longitudinal furrow is a narrow, smooth zone slightly depressed into the external surface of the exoskeleton. The glabella is thus divided into a subparallel-sided, median lobe which expands forward into the anterior lobe, and the composite lateral lobe is only slightly narrower (tr.) than the median lobe. Axial furrow in front of eye lobe (Pl. 34, fig. 9) curves forward and inward and is continuous with preglabellar furrow, both being of similar depth to lateral furrow 3p. Immediately behind the eye lobe the axial furrow (Pl. 32, fig. 7; Pl. 34, figs. 7, 11) is obsolete (there is a slight change in slope but no interruption of the tuberculation), but it becomes progressively better defined (that is, there is a smooth band interrupting the tuberculation and a definite furrow) as it approaches the distal end of the occipital furrow. At the proximal side of the axial furrow, opposite the mid-point of the eye lobe, there is a faint depression in the composite lobe; at the angulation in the longitudinal furrow there is a similar faint depression in the composite lobe. These depressions mark the ends of lateral glabellar furrow 1p, which does not extend across the composite lobe (Pl. 32, figs. 4, 6, 7; Pl. 34, figs. 7, 11). Posterior part of composite lobe gently convex, except adjacent to the outer part

of the occipital furrow, where it shows a slight additional convexity, which indicates the occipital lobe (Pl. 32, figs. 4, 6, 7,; Pl. 34, figs. 7, 11). The axial, lateral glabellar and longitudinal furrows have been described as they appear in the external surface of a well-preserved specimen. On other specimens (Pl. 34, figs. 6, 8) of comparable size to the original of Plate 32, figures 4, 6, 7, the posterior part of the longitudinal furrow, lateral glabellar furrow 1p, and the posterior part of the axial furrow may appear much deeper. This is because in these specimens the exoskeleton has been stripped off, and they are preserved in part as moulds of the internal surface. Specimens which have the exoskeleton partly stripped off (Pl. 34, fig. 8) show this difference in apparent depth of furrows clearly. In the internal moulds lateral glabellar furrow 1p runs straight outward and slightly forward (Pl. 34, fig. 6), and the occipital lobe may be completely outlined by a shallow furrow (Pl. 34, fig. 6) or only partially so outlined (Pl. 34, fig. 8).

Cheek (Pl. 34, figs. 7, 9, 11) subtriangular in outline, strongly convex and sloping steeply posterolaterally and laterally. Large eye lobe (of length [exs.] approaching one-third that of the cephalon) situated on the highest part of cheek adjacent to the axial furrow and opposite midlength of composite lateral glabellar lobe. The flat palpebral lobe forms only a small portion of upper surface of eye lobe; the eye surface displays a large number of tiny facets (Pl. 33, fig. 11). Anterolateral border of cheek flattened, narrow, outward sloping, continuous with narrow anterior border, lateral border widening posteriorly. The anteroventral surface of the border curls under to form the doublure, the inner margin of which lies directly beneath the border furrow of the cheek. Posterior border (Pl. 34, figs. 7, 9) is narrow and convex adjacent to occipital ring, is widened to form a small projection at about half its width, and outside this point it runs slightly forward to the base of the short, blunt genal spine. This spine is flat-topped, with a rounded tip. Anterior branch of suture (Pl. 32, fig. 5) runs forward and inward subparallel to the axial furrow, curves inward across the anterior border, where it lies on a low sutural ridge, and then runs along the anterior margin of the anterior border in a smooth curve (Pl. 33, fig. 7). Posterior branch of suture (Pl. 33, fig. 5; Pl. 34, figs. 9, 11) runs outward along posterior margin of eye lobe, then curves around across the cheek through about 90°, crossing the border furrow and the posterior border so that it

reaches the margin immediately outside the projection. Connective suture lies on downward and forward facing part of anterior border, and is approximately in projected line of axial furrow, so that it runs straight downward and inward, close to the inner margin of the doublure curving slightly outward. Rostral plate is wide (tr.) and short, the hypostomal furrow running in a course parallel to the rostral suture. Hypostome with middle body sub-trapezoidal in outline, divided by short, transverse middle furrow into a large anterior and a small posterior lobe. Anterior border lacking, the hypostomal suture running along the margin of the middle body. Anterior wing (Pl. 33, fig. 4) small, triangular, upwardly directed. Opposite middle furrow margin of lateral border swings abruptly outward so that posterior part of border is broad (tr.), and continuous with the broad, deeply-notched posterior border. Doublure extends beneath these broad posterior and lateral borders. In the doublure anterior to the median notch there is a sharp fold running in an inverted U-shaped course (Pl. 33, fig. 6). Cephala with the hypostome in position (Pl. 33, figs. 1, 2, 5; Text-fig. 6) show how the hypostome fits along the suture, and that the anterior wing points upward toward the anterior extremity of the axial furrow, where the anterior pit is situated. Between the lateral notch (*ln* in Text-fig. 6a) and the cephalic doublure is an oval opening through which the antennule probably protruded. The shoulder lies close to the cephalic doublure, and behind this point the borders of the hypostome project back so that at the farthest point they lie beneath the axial ring of the second segment.

Thorax of 11 segments. Broad, moderately convex axis tapers back, posterior margin of axial ring curving slightly forward medially, articulating furrow having a corresponding curvature, deepest distally. Articulating half-ring long (sag.), median part extending beneath preceding ring to articulating furrow. Inner part of pleura horizontal, fulcra of successive segments in line parallel to axial furrows, outer part of segment bent down at about 45° at fulcrum. Outer part of pleura curved, blade-like in form, posterior portion near the fulcrum overlaps the anterior margin of the immediately following segment; the projection on the posterior border of the cephalon is in line with the fulcra and overlaps the anterior margin of the following segment. The genal spine lies immediately outside and above the tip of the blade-like first pleura. Narrow, shallow pleural furrow curves

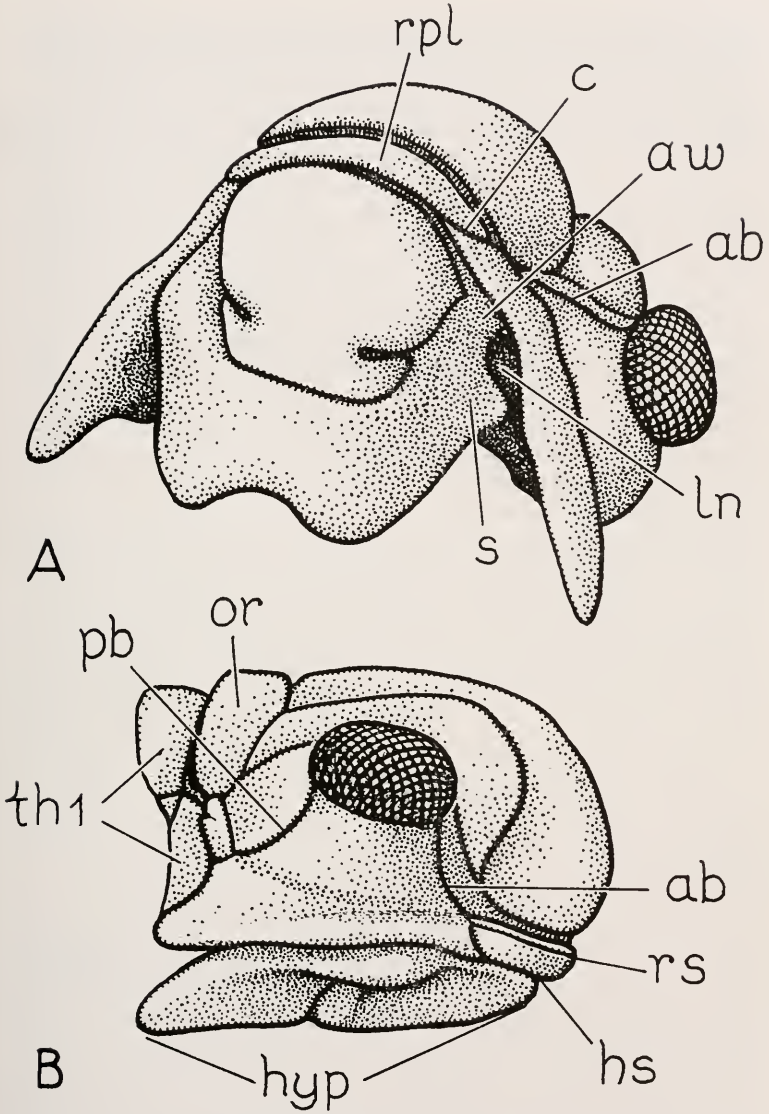

FIG. 6. *Apatolichas jukesi* (Billings). A, cephalon, oblique ventral view, *c.* X 4. B, cephalon and first thoracic segment, right lateral view, *c.* X 4. Based on original of Plate 33, figures 2, 5. Abbreviations: *ab,* anterior branch of suture; *aw,* anterior wing of hypostome; *c,* connective suture; *hs,* hypostomal suture; *hyp,* hypostome; *ln,* lateral notch of hypostome; *or,* occipital ring; *pb,* posterior branch of suture; *rpl,* rostral plate; *rs,* rostral suture; *s,* shoulder; *th* 1, first thoracic segment.

outward and backward to fulcrum, on outer part of segment extends about one-third of the width before dying out. Pygidium with axis rapidly tapering into a blunt point, which is not extended by a post-axial ridge. First axial ring well-defined by deep ring furrow; medially there is an additional flexure a short distance in front of the ring furrow. The depressed region of the ring between this flexure and the first ring furrow appears to correspond to the articulating half-ring of the succeeding ring. Second and third rings outlined by much fainter ring furrows which die out medially. Triangular tip behind third ring furrow with marked medial depression situated slightly in advance of the midlength. Pleural regions horizontal adjacent to axis, outer parts sloping gently outwards. Outer parts of pleural regions subdivided by deep notches into three broad, blade-like spines, the first two of approximately equal size, the third pair lobate in outline, separated by a shallow median posterior notch, and with a small, blunt point. Inner parts of pleural regions with first pleural furrow curving outward and backward to die out at base of pleural spine. Second and third pleural furrows are extremely short, close to axis, and outwardly and backwardly directed. Position of first interpleural furrow faintly indicated on large specimens (Pl. 32, fig. 9) by change in slope running between posterior margin of first pleural spine and first ring furrow. On small specimens (Pl. 33, figs. 9, 10) first interpleural furrow complete or dying out distally. Second interpleural furrow absent. Broad doublure extends beneath thoracic segments to fulcrum, and beneath outer parts of pleural regions of pygidium. Behind axis (Pl. 33, fig. 8) inner edge of doublure is flexed upward where it lies immediately beneath the tip of the axis.

External surface of exoskeleton, except in furrows, covered by closely spaced tubercles of varying size. These tubercles are present on the palpebral lobe and along the posterior margin of the articulating half ring; on the posterior part of the occipital ring the tubercles are small and closely spaced. Along the edges of the exoskeleton, and around the cephalic border and on the doublures, there are strong, raised, anastomosing lines. Similar lines, branching more frequently, are present on the lateral and posterior borders of the hypostome. On the median anterior part of the anterior glabellar lobe the tuberculation dies out and gives place to a smooth surface impressed by pits (Pl. 34, fig. 9). The external surface of the middle body of the hypostome bears similar scattered, shallow pits (Pl. 33, fig. 3).

Discussion. I have placed in the species all of Billings' original material, including 671b (see discussion of the genus). GSC 671, apparently the original of Billings' figure 323a, and having the left genal spine preserved, is like the holotype in not showing a groove crossing the median lobe and in having a faint change of slope suggesting lateral furrow 1p.

The smallest cephalon (Pl. 34, figs. 1, 3, 4) is 1.8 mm. in length (sag.), the largest one (Pl. 34, figs. 9, 11) about 7.8 mm. in length. These may all be holaspides. In the small cephalon the axial, anterior lateral glabellar and longitudinal furrows are relatively deeper, as are the pleural furrows (compare Pl. 34, fig. 3 with Pl. 32, fig. 6), and the eye lobe is relatively larger. These differences are apparent in larger cephala (Pl. 34, figs. 2, 5 and 10, of length [sag.], respectively, 2.7 mm. and 4.0 mm.), though they are accentuated by stripping off of the exoskeleton of these specimens. The original of Plate 34, figure 10, is notable in that the lateral occipital lobe is clearly outlined; far more clearly than in the larger specimen shown in Plate 34, figure 6. Thus the differences in depth of furrows in different specimens seems to be dependent on size as well as preservation.

The attachment of the hypostome (Pl. 33, figs. 1, 2, 5; Text-fig. 6) is like that in *Hemiarges* (Tripp, *in* Moore, 1959, fig. 393, 8b; Whittington, 1961a, pl. 57, figs. 11, 12, 17), though the rostral plate of *A. jukesi* does not have the long, posterolateral points of that of *H. aquilonius.*

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EXPLANATION OF PLATES 1-36

To make the photographs each specimen and the immediately surrounding area was coated with a dilute "opaque" to give a dull surface, dark gray in colour. A light coating of ammonium chloride was then applied. Small specimens were mounted on pins, and these have been blacked out; otherwise the photographs have not been retouched. It is arbitrarily decided that the plane running through the posterior margin of the occipital or axial ring shall run in the dorsoventral direction, and views are described accordingly. Exterior views have been taken in a direction lying in the sagittal plane to give either the fullest possible view of the exoskeletal surface or to show particular features. Oblique views have been taken in a direction lying at an angle to the sagittal plane.

PLATES

PLATE 1

Geragnostus clusus n. sp.

Figure

1-6 Holotype enrolled exoskeleton, GSC 16171, dorsal of cephalon, dorsal of thorax, right lateral, dorsal of pygidium, anterior, oblique views, X 12.

7-9 Cephalon, dorsal, anterior, posterior views, X 9. GSC 16172.

10, 11 Pygidium, dorsal, left lateral views, X 9. GSC 16173.

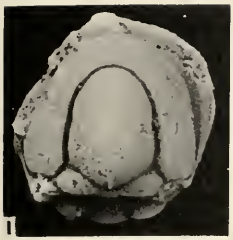
12 Cephalon, dorsal view showing genal spines, exoskeleton partly stripped off, X 9. GSC 16174.

13-17 Enrolled specimen with exoskeleton stripped from furrows and borders, dorsal views of cephalon, pygidium, and thorax, left lateral view, anterior view, X 9. GSC 16175.

Selenoharpes fragilis (Raymond, 1925)

Boulder in Cow Head Group from Stearing Island, western Newfoundland.

18-20 Lectotype (here selected), YPM 13036, original of Raymond, 1925, pl. 1, fig. 10, dorsal, left lateral, anterior views, X 4½.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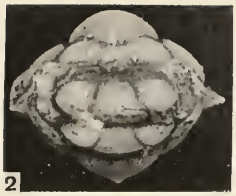
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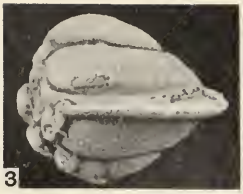
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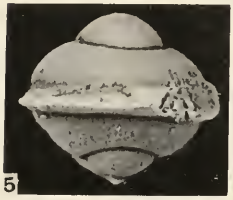
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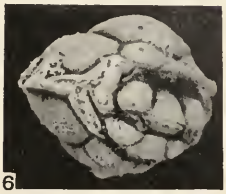
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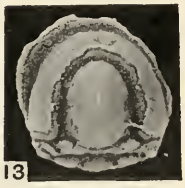
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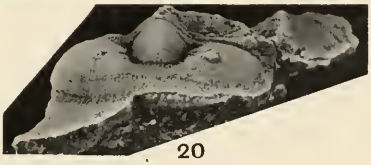
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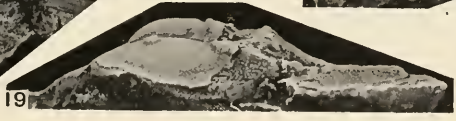
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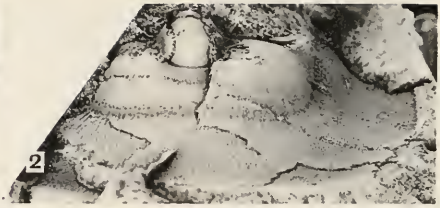
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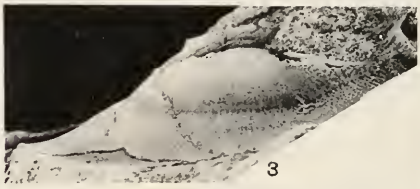
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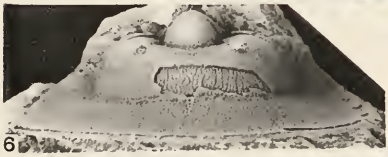
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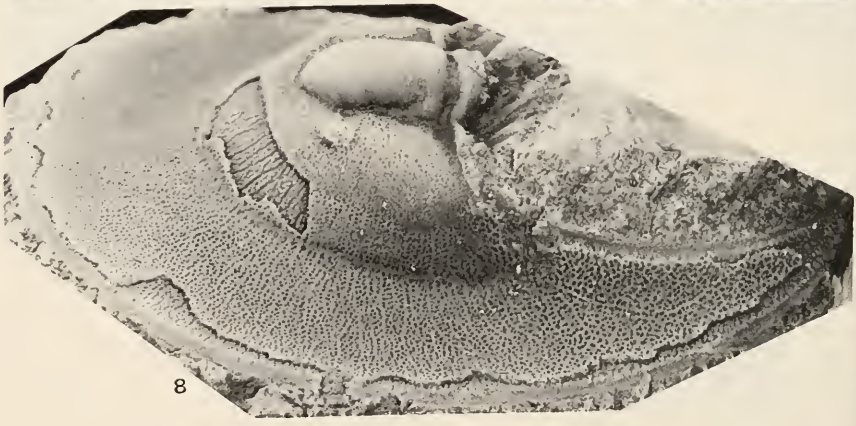
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PLATE 2

Selenoharpes fragilis (Raymond, 1925)

Boulder in Cow Head Group from Stearing Island, western Newfoundland.

Figure

1-3 Latex cast of external mould of cephalon, YPM 13036, original of Raymond, 1925, pl. 1, fig. 11, dorsal, anterior, left lateral views, X 4½.

Selenoharpes vitilis n. sp.

4 Glabella and cheek lobes, dorsal view, X 3. GSC 16177.

5-8 Holotype, GSC 16176, incomplete cephalon, left lateral, anterior, dorsal views, X 4½; oblique view showing genal caeca and genal ridge, X 8.

PLATE 3

Selenoharpes vitilis ?

Figure

1, 5 Cephalon having shorter and less strongly incurved prolongations, dorsal, right lateral views, X 4½. GSC 16178.

Selenoharpes vitilis n. sp.

2, 3, 4, 6 Thorax and pygidium, dorsal, left lateral, dorsal views of thorax, x 6; dorsal view of pygidium, X 10. GSC 16179.

7, 9, 10 Incomplete small cephalon, anterior, right lateral, dorsal views, X 6. GSC 16180.

8 Part of lower lamella of fringe, ventral view, X 3. GSC 16181.

11 Cephalon, oblique view showing genal caeca extending across cheek lobe and fringe, and genal ridge on cheek lobe, X 8. GSC 16182.

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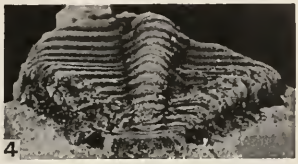
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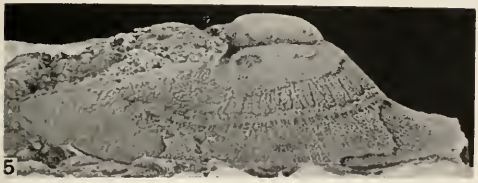
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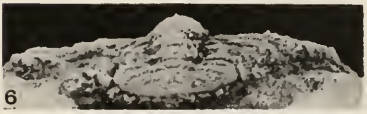
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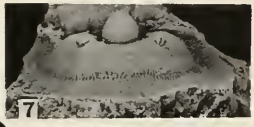
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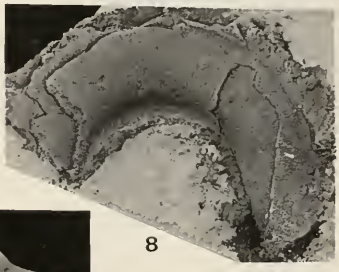
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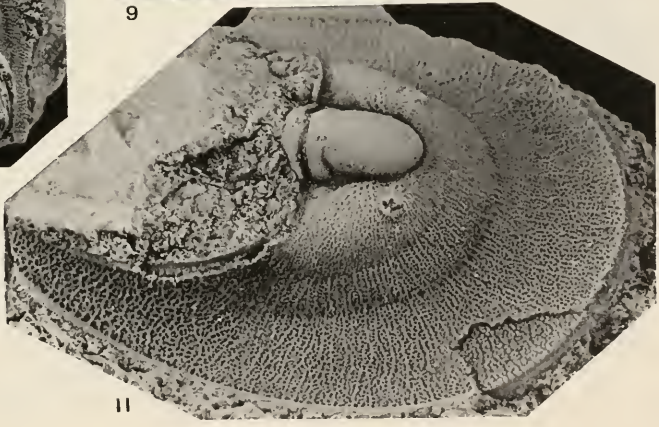
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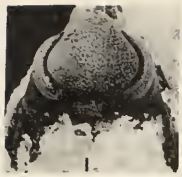
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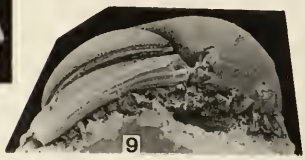
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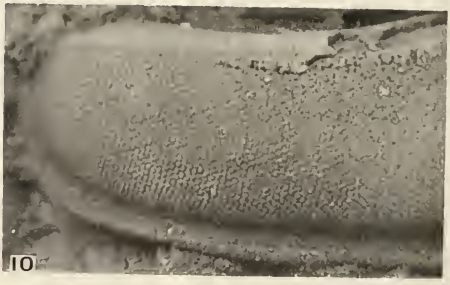
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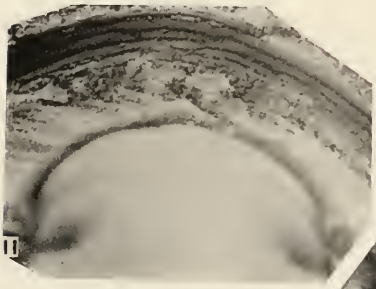
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PLATE 4

Remopleurides ligulus n. sp.

Figure

1, 4, 5 Small cephalon, dorsal, left lateral, anterior views, X 6. GSC 16146.

2, 3, 7 Holotype, incomplete cephalon, GSC 16145, dorsal, ventral, right lateral views, X 6.

6, 8-10 Incomplete cephalon, dorsal, right lateral, oblique ventral views, X 6; eye surface, X 30. GSC 16147.

Phaseolops sepositus n. gen., n. sp.

11 Anterior portion of cephalon, dorsal view, exoskeleton of border removed to show external mould of doublure, crossed by connective sutures that converge and meet at the inner margin, X 30. GSC 16149.

12, 13 Cephalon, external surface of eye lobe, oblique view, X 30. GSC 16150.

PLATE 5

Phascolops sepositus n. gen., n. sp.

Figure

1-3 Holotype, incomplete exoskeleton, GSC 16148, dorsal, right lateral, dorsal views of flexed exoskeleton, X 10.

4, 5 Cephalon and two thoracic segments, dorsal, left lateral views, X 8. GSC 16151.

6 Small cephalon and six thoracic segments, dorsal view, X 30. GSC 16152.

Isocolus dysdercus n. sp.

7, 9 Cephalon, distal portions of exoskeleton stripped off to reveal external mould of doublure; anterior view, X 30, right lateral view, X 15. GSC 16154.

8, 10 Cephalon, distal parts of exoskeleton stripped off to reveal external mould of doublure; anterior view, X 30; oblique view showing facets of eye surface and doublure, X 30. GSC 16155.

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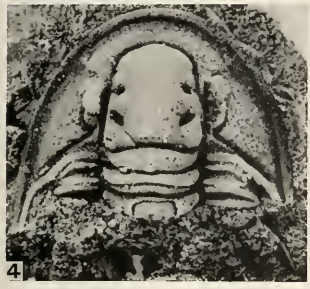
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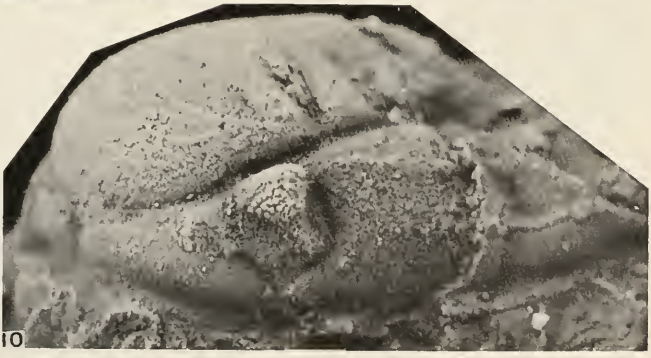
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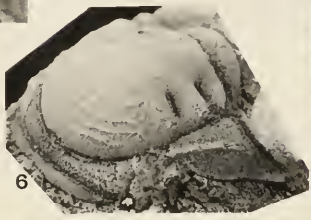
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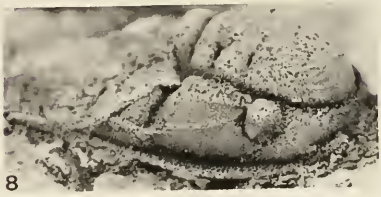
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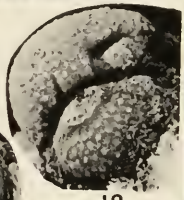
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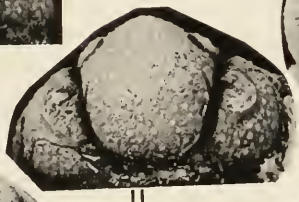
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PLATE 6

Isocolus dysdercus n. sp.

Figure

1-4 Holotype exoskeleton, GSC 16153, dorsal, right lateral, dorsal, anterior views of flexed exoskeleton, X 12.

5, 6 Cranidium, dorsal and oblique views showing raised lines on external surface, X 15. GSC 16156.

7, 9 Thorax and pygidium, dorsal, right lateral views, X 10. GSC 16157.

8 Cephalon, oblique view showing cheek, posterior branch of suture, and genal spine, X 15. GSC 16158.

16 Cephalon, exoskeleton stripped off in front of glabella to reveal external mould of doublure, anterior view, X 30. GSC 16159.

Dimeropygid cephalon, gen. ind.

10-12 Incomplete cephalon, internal mould, dorsal, anterior, left lateral views, X 9. GSC 16160.

? *Ischyrophyma* sp. ind.

13-15 Incomplete cephalon, internal mould, left lateral, dorsal, anterior views, X 9. GSC 16161.

PLATE 7

Ischyrotoma twenhofeli Raymond, 1925

Figure

1, 2, 4 Holotype, YPM 13055, incomplete cephalon with exoskeleton including borders stripped off, dorsal, right lateral, anterior views, X 4. Original of Raymond, 1925, pl. 3, figs. 1, 2.

3, 5, 6 Cephalon, much of exoskeleton and right lateral border adhering, anterior, right lateral, dorsal views, X 6. GSC 16162.

7-11 Enrolled exoskeleton, exoskeleton and cephalic borders largely stripped off, dorsal of cephalon, right lateral, dorsal of thorax, dorsal of pygidium, anterior views, X 4. GSC 16163.

12 Cephalon, exoskeleton and borders stripped off to reveal external mould of doublure, anterior view showing connective sutures, X 6. GSC 16164.

13 Cephalon with cephalic border complete, anterior view showing anterior branches of sutures and narrow rostral plate, X 6. GSC 16165.

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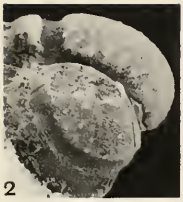
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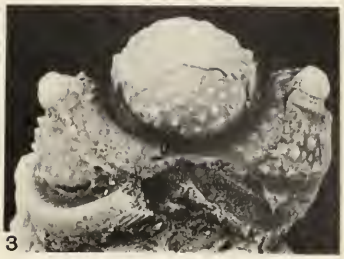
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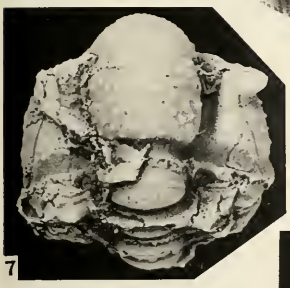
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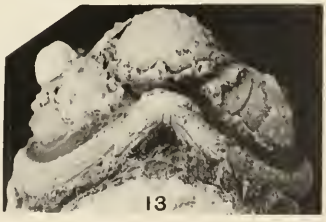
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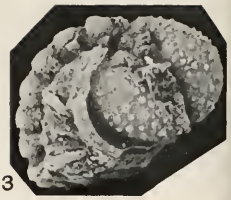
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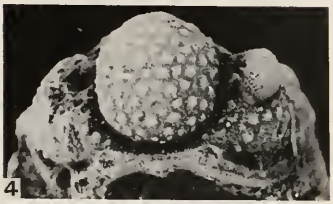
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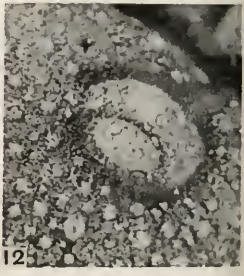
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PLATE 8

Ischyrophyma tuberculata n. gen., n. sp.

Figure	
1-3, 5	Holotype, GSC 16166, cephalon and six enrolled thoracic segments; dorsal of cephalon, dorsal of thorax, right lateral views, X 9; anterior view showing external mould of doublure and connective sutures, X 15.
4	Cephalon, anterior view showing sutures and rostral plate, X 15. GSC 16167.
6, 8, 9	Cephalon having most of exoskeleton stripped off and border broken away anteriorly to show external mould of doublure and connective sutures; anterior view, X 15; dorsal, left lateral views, X 9. GSC 16169.
7	Cephalon, left lateral view showing borders and small genal spine, X 9. GSC 16168.
10	External surface of eye lobe, oblique view, showing facets, X 30. GSC 16170.

Glaphurus divisus n. sp.

11	Cephalon, oblique view showing cheek and genal spine, X 6. GSC 16184.
12, 13	Holotype, GSC 16183, cephalon; oblique view of right eye lobe, X 30; oblique view showing sutures and border spines, X 15.
14	Cephalon, border stripped off anteriorly to reveal external mould of doublure showing absence of connective sutures, anterior view, X 9. GSC 16185.

PLATE 9

Glaphurus divisus n. sp.

Figure	
1, 2, 5	Holotype, cephalon, GSC 16183, dorsal, anterior, right lateral views, X 10.
3, 4, 6	Cranidium, dorsal, left lateral, anterior views, X 9. GSC 16186.
8	Cephalon and three thoracic segments, dorsal view, X 9. GSC 16187.

Nileus affinis Billings, 1865

7, 11, 12	Incomplete exoskeleton, anterior, right lateral views, X 2; dorsal view, X 3. GSC 889, Lévis formation, Island of Orleans, Quebec.
9, 10	Three thoracic segments and pygidium, posterior, dorsal views, X 3. GSC 16189.

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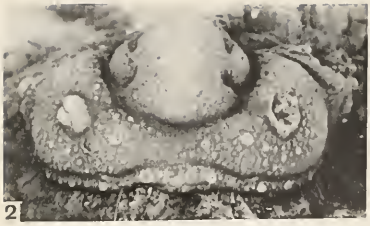
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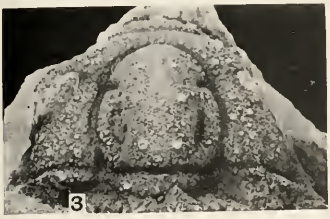
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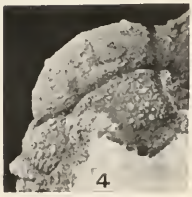
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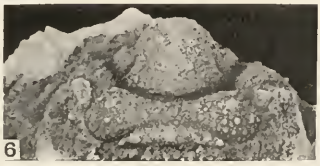
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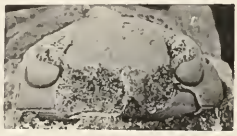
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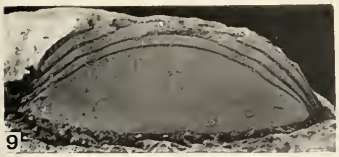
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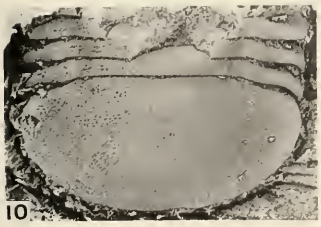
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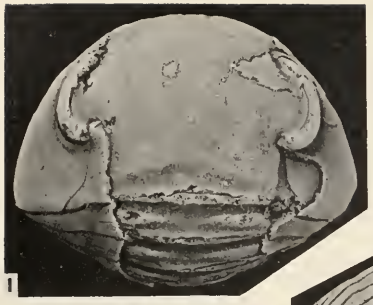
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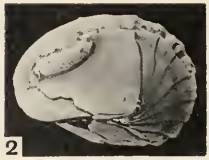
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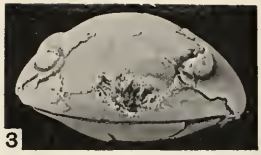
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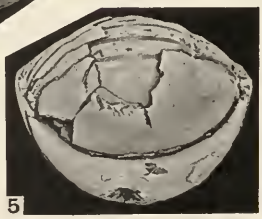
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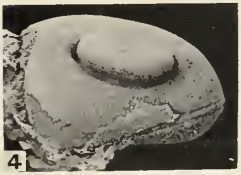
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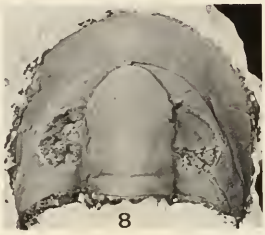
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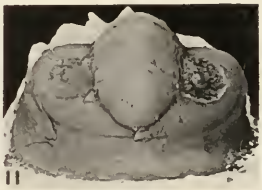
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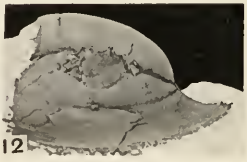
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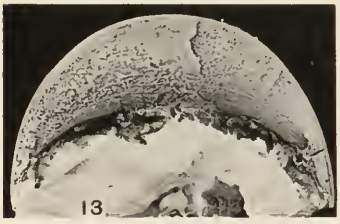
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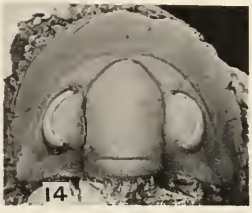
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PLATE 10

Nileus affinis Billings, 1865

Figure

1-3, 5, 6 Lectotype (here selected), GSC 889a, original of Billings, 1865, fig. 261a, b, enrolled exoskeleton, dorsal view of cephalon, X 3; left lateral, anterior, dorsal of pygidium, dorsal view of thorax, X 2. Lévis Formation, Island of Orleans, Quebec.

4, 7, 10, 13 Internal mould of cephalon, right lateral, dorsal, anterior, ventral views, X 3. GSC 16188.

Bathyurellus nitidus Billings, 1865

8, 11, 12 Cephalon, dorsal, anterior, right lateral views, X 2. GSC 16190.

9 Complete exoskeleton, dorsal view, X 3. GSC 16191.

14, 15, 17 Cephalon, dorsal, right lateral, anterior views, X 3. GSC 16192.

16 External surface of eye lobe, oblique view, X 20. GSC 16193.

PLATE 11

Bathyurellus nitidus Billings, 1865

Figure

1, 5 Thorax and pygidium showing doublure, dorsal, posterior views, X 4½. GSC 16194.

2, 3 Large pygidium, dorsal, posterior views, X 1.3. GSC 16195.

4, 6, 7, 12 Cephalon with blunt genal spine, anterior and right lateral borders removed to show doublure; right lateral, anterior, left lateral, dorsal views, X 3. GSC 16196.

8, 9, 10 Degree 6 meraspid, anterior, dorsal, right lateral views, X 9. GSC 16197.

11, 14 Degree 8 meraspid, dorsal, left lateral views, X 6. GSC 16198.

15 Part of cephalon, anterior border removed to show external mould of doublure. Connective sutures run in "Y" form, doublure on right side is missing, dorsal view, X 6. GSC 16199.

Lloydia saffordi (Billings, 1860)

"Quebec group, Cow Head," collected by J. Richardson.

13, 16, 17 Incomplete pygidium, posterior, dorsal, right lateral views, X 2. GSC 639a.

18 Incomplete pygidium, showing doublure on right side, dorsal view, X 1.3. GSC 639.

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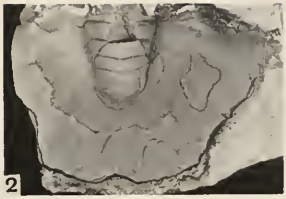
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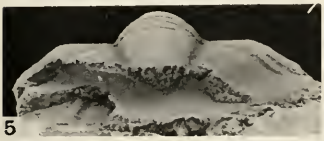
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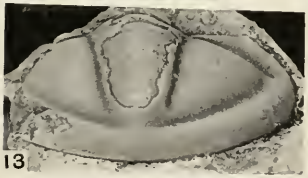
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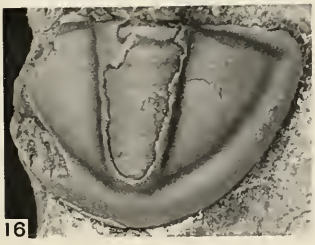
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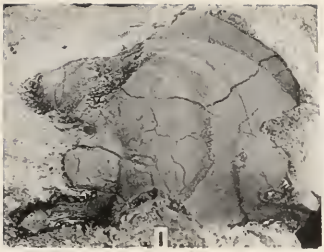
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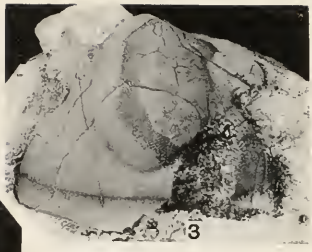
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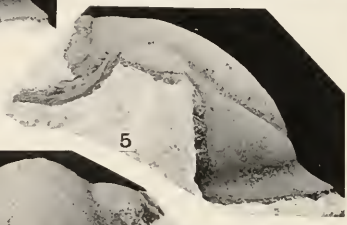
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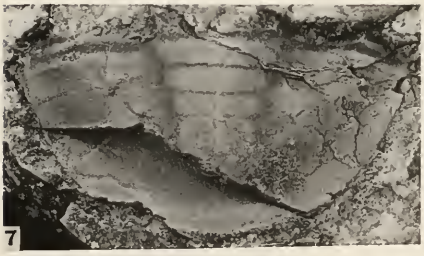
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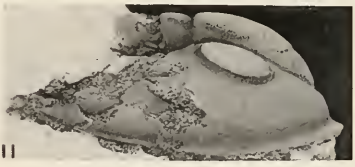
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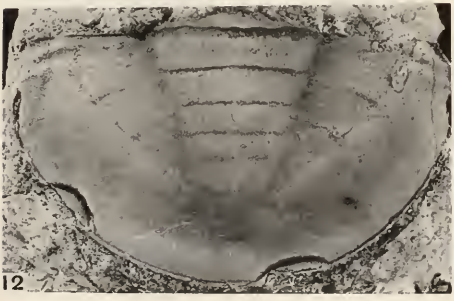
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PLATE 12

Uromystrum fraternum (Billings, 1865)

Figure

1-3 Lectotype, GSC 643, original of Billings, fig. 251a, incomplete cranidium, dorsal, right lateral, anterior views, X 1.3. "Division P, Cow Head."

4-6 Cranidium, dorsal, right lateral, anterior views, X 1.2. GSC 16200.

7, 10 Incomplete pygidium, GSC 643a, ? original of Billings, fig. 251b, dorsal, posterior views, X 2. "Division P, Cow Head."

12, 13 Pygidium, dorsal, left lateral views, X 1.8. GSC 16201.

Uromystrum formosum (Billings, 1865)

8, 9 Incomplete cranidium, GSC 644a, dorsal, left lateral views, X 2. "Division P, Cow Head."

11, 14 Incomplete cephalon, showing part of doublure on right side, right lateral, dorsal views, X 3. GSC 16202.

PLATE 13

Cromystrum formosum (Billings, 1865)

Figure

1, 2, 4 Lectotype (here selected), GSC 664, incomplete cephalon with five thoracic segments, dorsal, left lateral, anterior views. X 4½. "Division P, Cow Head." Possible original of Billings' fig. 250.

3, 5, 6 Incomplete cephalon, dorsal, left lateral views, X 4½; exterior view showing connective sutures crossing doublure, X 9. GSC 16203.

Cromystrum patulum n. sp.

7, 9, 10 Holotype, GSC 16204, cephalon, thoracic segments and pygidium presumably of one individual, dorsal, anterior, left lateral views, X 3.

8, 11 Incomplete cephalon, dorsal view, right lateral view with genal prolongation broken away to show doublure, X 3. GSC 16205.

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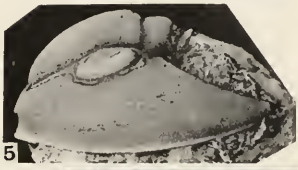
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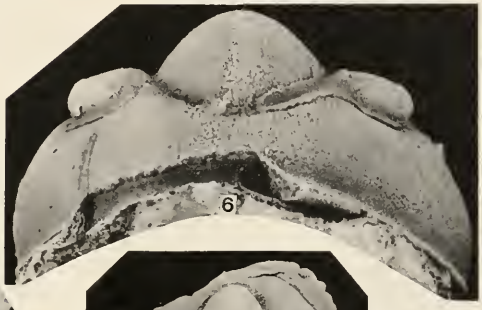
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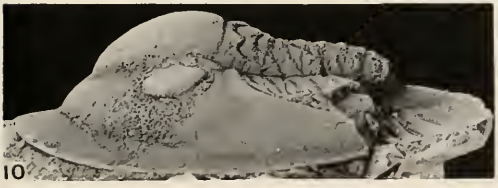
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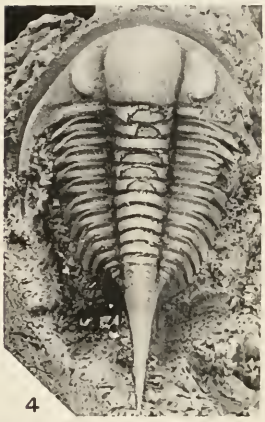
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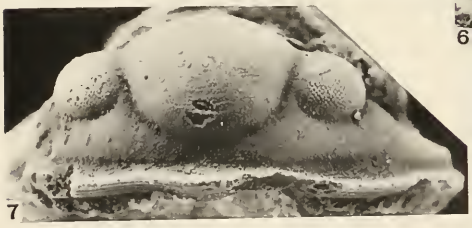
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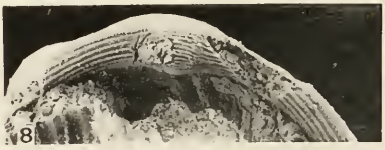
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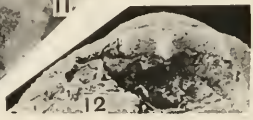
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PLATE 14

Uromystrum patulum n. sp.

Figure

1, 2 Incomplete exoskeleton, dorsal, left lateral views, X 3. GSC 16205.

Goniotelus kindlei n. sp.

3-6 Holotype, GSC 16206, exoskeleton, anterior, dorsal, right lateral, oblique views, X 9.

7, 8 Incomplete cephalon, anterior, ventral views showing doublure and ventrally-bulging rostral plate, X 15. GSC 16208.

9 Cephalon, right lateral view showing eye surface and tubercles on external surface, X 30. GSC 16207.

Goniotelus rostratus n. sp.

10-12 Incomplete cephalon, dorsal, left lateral, ventral views, latter two views showing ventrally-projecting median part of doublure, X 9. GSC 16210.

PLATE 15

Goniotelus rostratus n. sp.

Figure

1, 2, 4 Holotype, GSC 16209, incomplete cephalon and two thoracic segments, dorsal, left lateral, anterior views, X 4½.

3, 6 Small cephalon, anterior, dorsal views, X 6. GSC 16211.

Goniotelus sp. ind.

5, 7, 8 Incomplete cephalon, left lateral, dorsal, anterior views, X 4½. GSC 16212.

Illaenus tumidifrons Billings, 1865

9 Internal mould of cephalon, ventral view, showing rostral plate, X 4. GSC 16214.

10, 11 Cephalon, the peripheral parts of which have been excavated to reveal the doublure, left lateral, ventral views, the latter showing connective sutures defining the rostral flange, X 6. GSC 16215.

12, 13 Pygidium, posterior, dorsal views, X 6. GSC 16213.

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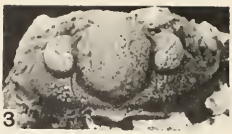
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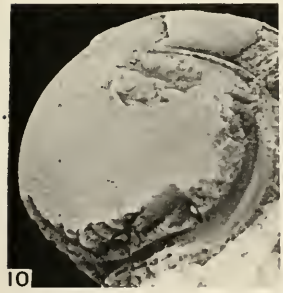
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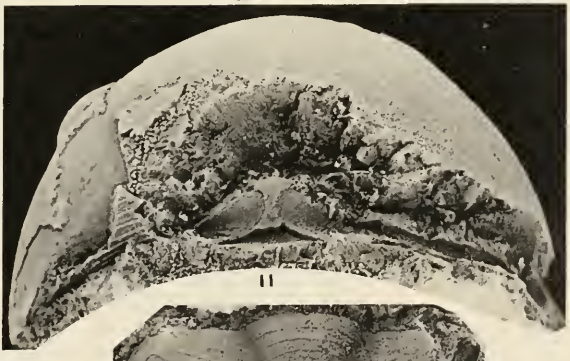
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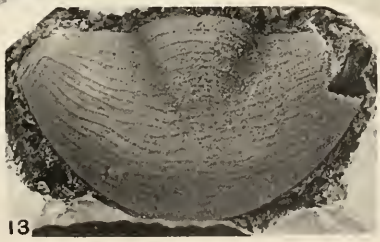
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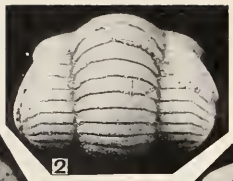
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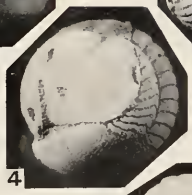
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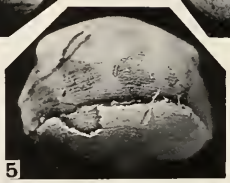
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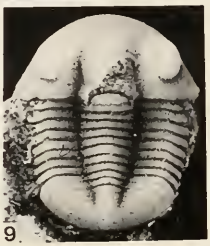
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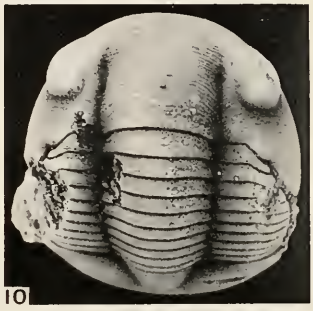
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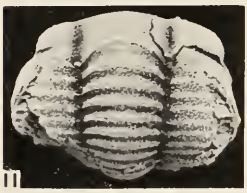
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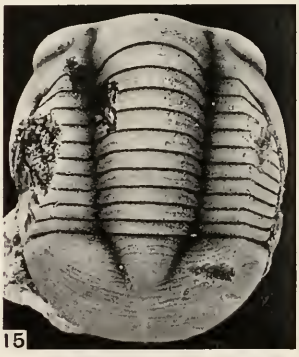
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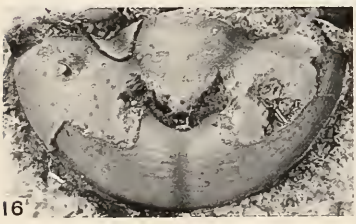
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PLATE 16

Illaenus tumidifrons Billings, 1865

Figure	
1-5	Lectotype (here selected), GSC 662j, small enrolled individual, probable original of Billings' fig. 264b, dorsal views of cephalon, thorax, pygidium, left lateral view, anterior view, X 4. "Division P, Cow Head."
6, 7, 9	Degree 8 meraspid exoskeleton, right lateral, anterior, dorsal views, X 9. GSC 16216.
8, 11, 12, 13	Small enrolled individual, dorsal views of cephalon and thorax, right lateral view, dorsal view of pygidium, X 9. GSC 16217.
10, 14, 15, 17	Exoskeleton, dorsal view, right lateral view, dorsal view, anterior view, X 6. GSC 16218.
16	Pygidium with parts of pleural regions removed to reveal doublure, dorsal view, X 4. GSC 16219.

PLATE 17

Illaenus consobrinus Billings, 1865

Figure	
1, 2, 4	Holotype, GSC 676c, original of Billings fig. 266a, b, dorsal, left lateral, anterior views, X 2. "Division P, Cow Head."
3, 5, 6, 7	Internal mould of medium-sized cephalon, dorsal, left lateral, anterior, ventral views, X 3. GSC 16220.
8, 9, 11, 14	Cephalon which has been excavated to reveal doublure on right side and anteriorly, dorsal, right lateral, anterior views, X 3; ventral view showing connective sutures and rostral flange, X 6. GSC 16221.
10, 12, 13	Internal mould of small cephalon, right lateral, dorsal, anterior views, X 6. GSC 16222.
15	Incomplete thorax and pygidium which has been excavated to reveal doublure, dorsal view, X 3. GSC 16223.
16	Oblique view of doublure of free cheek, X 3. GSC 16224.

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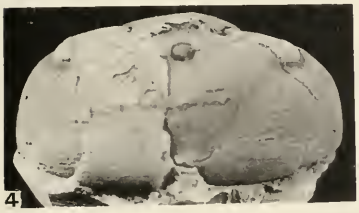
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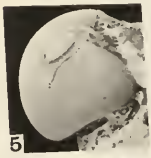
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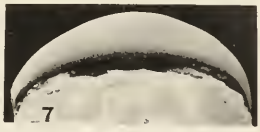
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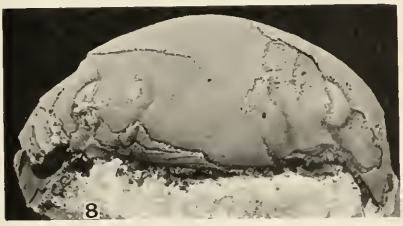
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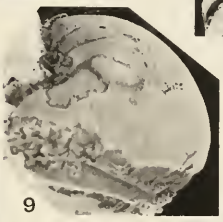
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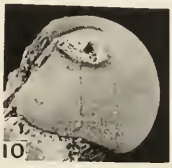
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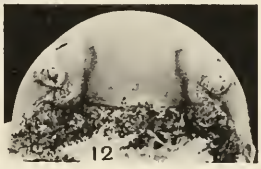
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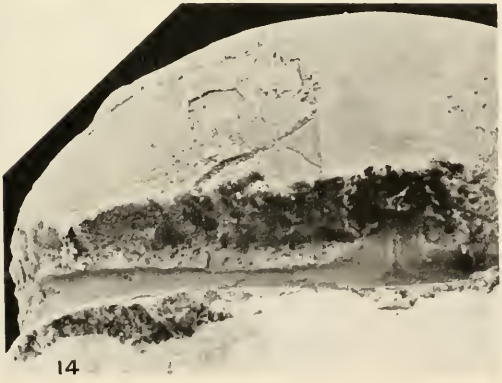
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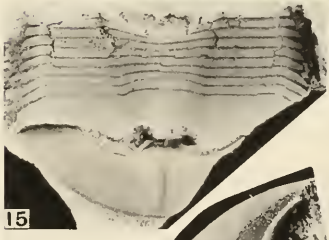
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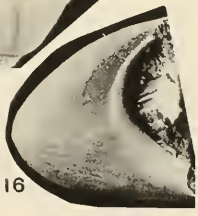
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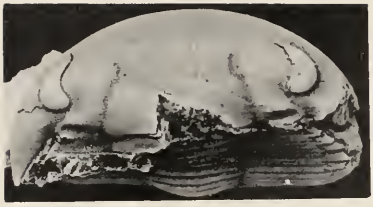
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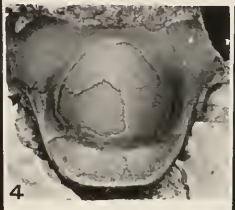
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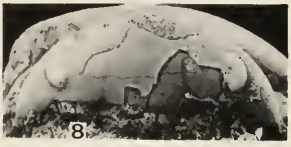
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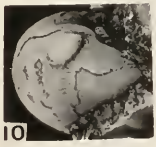
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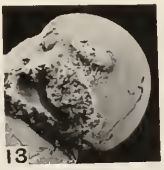
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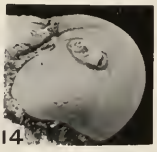
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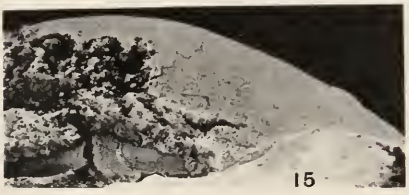
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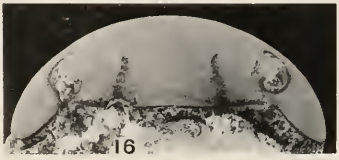
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PLATE 18

Illaenus consobrinus Billings, 1865

Figure	
1, 2, 3, 5	Complete exoskeleton slightly disarticulated, dorsal views of cephalon, thorax, pygidium; left lateral view, X 4½. GSC 16225.
	Illaenid hypostome
4, 7	Exterior, left lateral views, X 4½. GSC 16226.
	Illaenus bucculentus n. sp.
6, 9, 12, 13	Holotype, GSC 16227, dorsal, anterior, ventral, right lateral views, X 3.
8, 10, 11	Small cephalon, dorsal, left lateral, anterior views, X 4. GSC 16228.
14, 16	Internal mould of medium-sized cephalon, right lateral, dorsal views, X 3. GSC 16229.
15	Ventral view of cephalon that has been excavated to reveal anterior part of doublure, connective sutures and rostral flange, X 6. GSC 16230.

PLATE 19

Illaenus sp. ind. 1

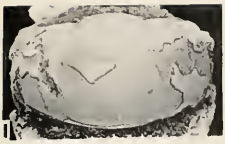
Figure	
1-3	Cephalon and 7 thoracic segments, anterior, dorsal, right lateral views, X 4½. GSC 16231.
4, 7	Cephalon, anterior, ventral views, showing anterior branches of suture and rostral plate, X 4½. GSC 16232.

Illaenus sp. ind. 2

5, 6, 8, 9	Internal mould of cephalon, right lateral, dorsal views, X 3; ventral view showing rostral plate, X 6; anterior view, X 3. GSC 16233.

Illaenus spiculatus n. sp.

10, 11, 12, 15, 17	Holotype, enrolled exoskeleton, GSC 16234, dorsal views of cephalon, thorax, left lateral view, dorsal view of pygidium, anterior view, X 6.
13	Cephalon, posterolateral view of right eye lobe, X 30. GSC 16235.
14, 16, 18	Cephalon, right lateral, dorsal, anterior views, X 6. GSC 16236.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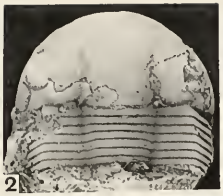
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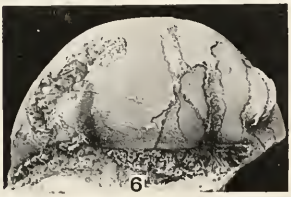
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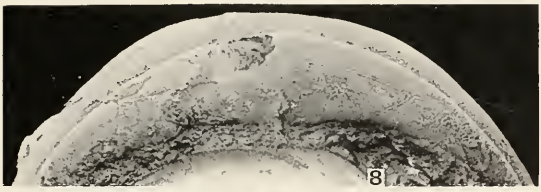
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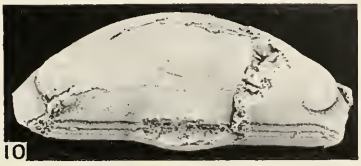
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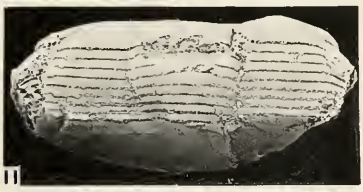
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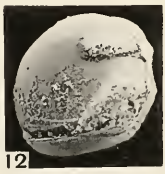
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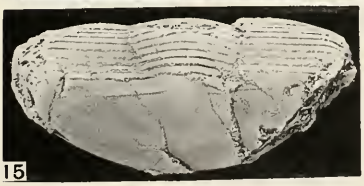
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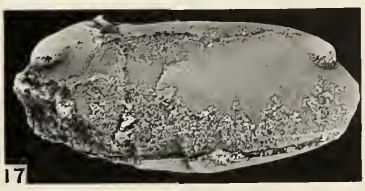
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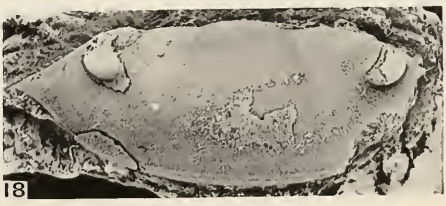
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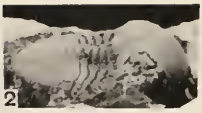
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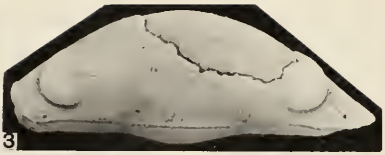
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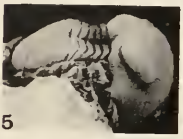
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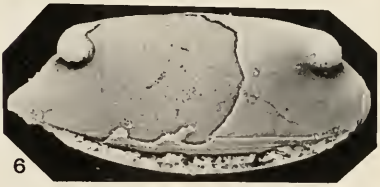
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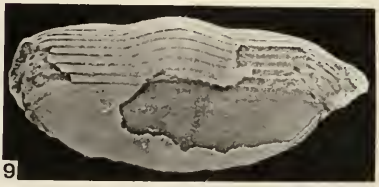
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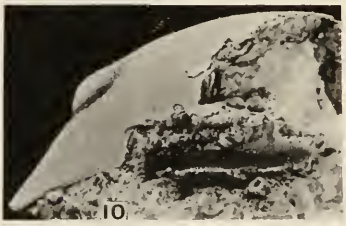
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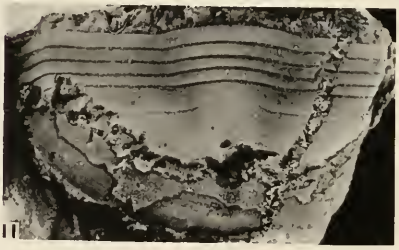
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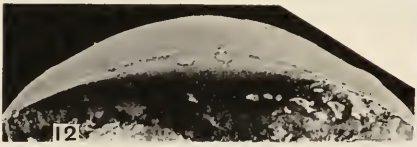
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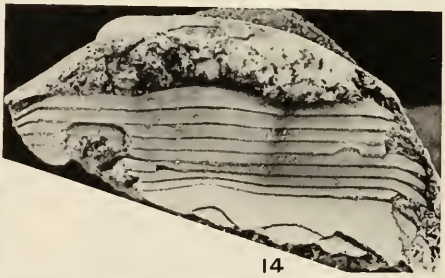
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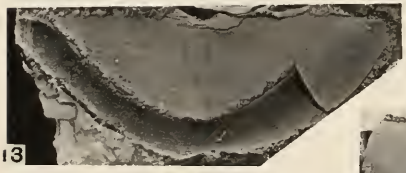
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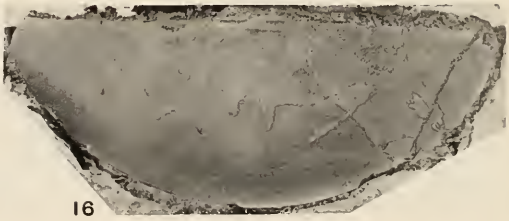
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PLATE 20

Illaenus spiculatus n. sp.

Figure	
1, 2	Degree 4 meraspid, dorsal, right lateral views, X 12. GSC 16237.
3, 6, 8, 9	Degree 7 enrolled meraspid, dorsal view of cephalon, anterior view, right lateral view, dorsal view of pygidium, X 9. GSC 16238.
4, 5, 7	Degree 5 meraspid, dorsal, right lateral, oblique views, X 9. GSC 16239.
10	Ventral view of cephalon, excavated anteriorly to show doublure and rostral flange, X 9. GSC 16235.
11	Four thoracic segments and pygidium, latter excavated to show doublure and median tongue, dorsal view, X 9. GSC 16240.
12, 14	Incomplete exoskeleton, ventral view of cephalon to show rostral plate, dorsal view to show thorax and part of pygidium, X 6. GSC 16241.

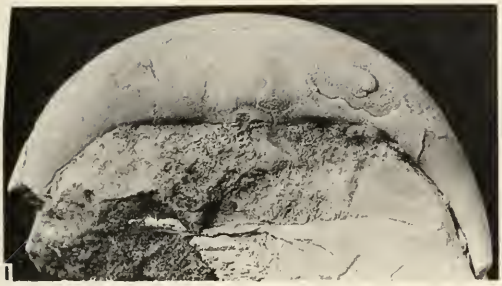
Harpillaenus arcuatus (Billings, 1865)

13	Pygidium, outer part of pleural regions excavated to reveal doublure, dorsal view, X 3. GSC 16242.
15, 16	Pygidium, right lateral, dorsal views, X 2. GSC 16243.

PLATE 21

Harpillaenus arcuatus (Billings, 1865)

Figure	
1-3	Holotype, incomplete cephalon, GSC 661b, original of Billings, 1865, fig. 265, dorsal, right lateral, anterior views, X 2. "Division P, Cow Head."
4, 5, 8	Incomplete cephalon, dorsal, anterior, left lateral views, X 2. GSC 16244.
6, 9	Incomplete cephalon and nine thoracic segments, dorsal view of latex cast, X 6; anterior view of internal mould, X 4. GSC 16245.
7	Two thoracic segments and pygidium, dorsal view, X 3, showing forward curve of tips of pleurae and of anterolateral corner of pygidium. GSC 16246.
10, 12	Internal mould of cephalon, anterior view, X 6; ventral view, X 9, showing anterior branches of suture and rostral plate. GSC 16247.
11, 13	Small almost complete cephalon, dorsal view, left lateral view, X 3. GSC 16248.
14	Oblique view of cephalon with peripheral part removed to show doublure, X 4½. GSC 16249.
15	Cephalon, anterior part removed to show doublure crossed by connective sutures, exterior view, X 9. GSC 16250.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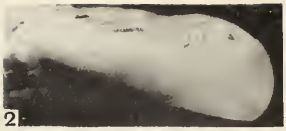
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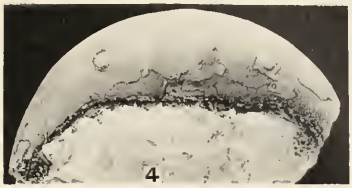
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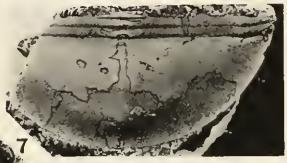
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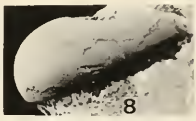
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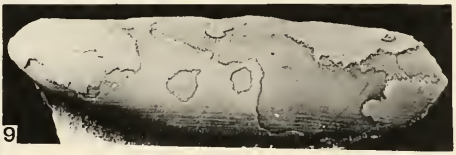
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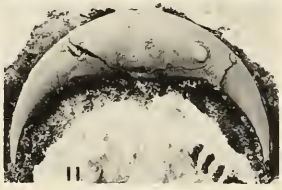
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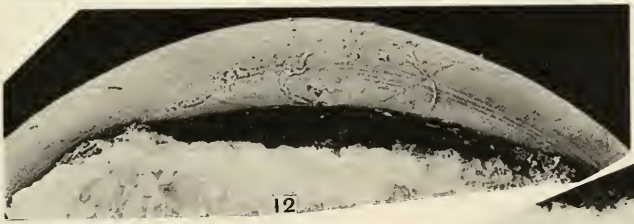
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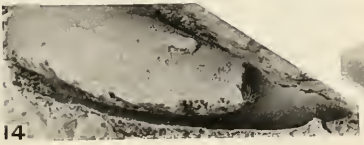
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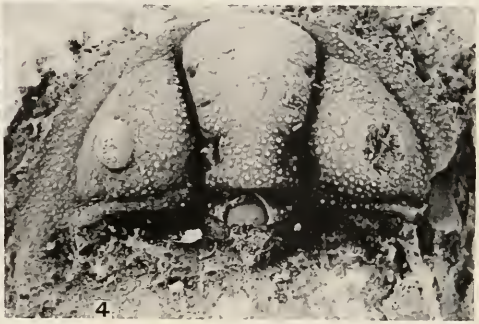
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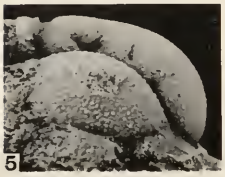
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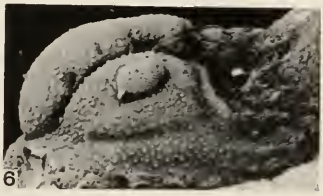
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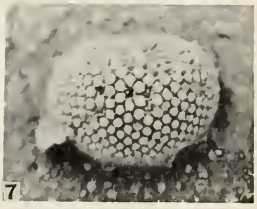
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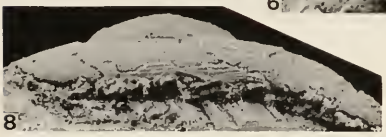
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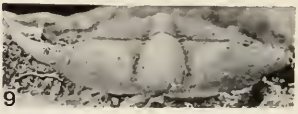
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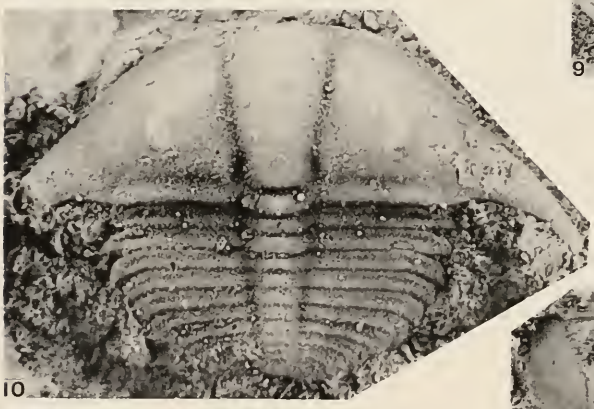
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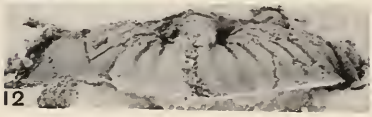
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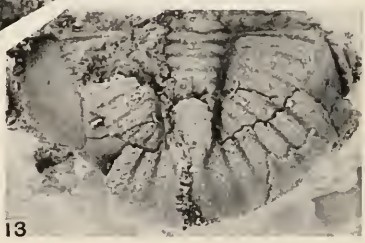
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PLATE 22

Perischoclonus capitalis Raymond, 1925

Figure	
1, 3, 5	Holotype, YPM 13049, incomplete cephalon, original of Raymond, 1925, pl. 10, fig. 13, anterior, dorsal, right lateral views, X 6.
2, 4, 6, 7	Cephalon with left eye lobe and genal spine, anterior view, dorsal view, left lateral view, X 8; eye lobe, oblique view, X 30. GSC 16251.
8	Cephalon, ventral view showing doublure and rostral plate, X 6. GSC 16252.
9, 10, 11	Degree 5 meraspid: anterior view, X 15; dorsal view, X 30; left lateral view, X 15. GSC 16253.
12, 13	Pygidium probably belonging to this species, posterior, dorsal views, X 6. GSC 16254.

PLATE 23

Lehua argus n. sp.

Figure

1, 2, 4 — Holotype cephalon, GSC 16255, anterior, dorsal, left lateral views, X 6.

3, 6, 8, 9, 11 — Incomplete cephalon, dorsal, anterior views, X 6; ventral view showing rostral plate, X 9; right lateral view, X 6; eye lobe, oblique view, X 30. GSC 16256.

5, 7 — Pygidium possibly belonging to this species, posterior view, dorsal view, X 3. GSC 16257.

Lehua vincula (Barrande, 1872)

Svatá Dobrotivá Shales, $D\gamma_2b$ (Uppermost Llanvirn), Sancta Benigna, Bohemia. Schary collection.

10 — Lectotype (here selected), MCZ 5568, original of Barrande, 1872, pl. 12, fig. 2, incomplete cephalon flattened in black shale, dorsal view, X 2.

12 — Incomplete cephalon and 9 thoracic segments, original of Barrande, 1872, pl. 12, fig. 4, flattened in black shale, dorsal view, X 2. MCZ 5567.

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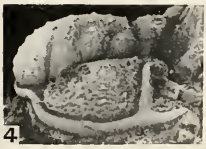
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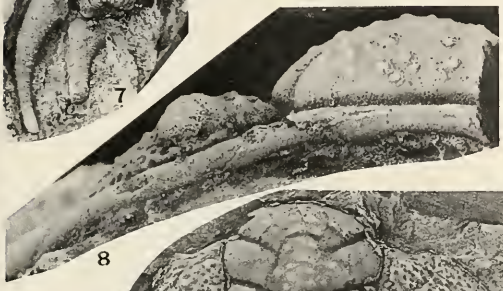
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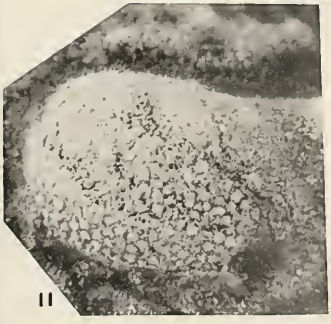
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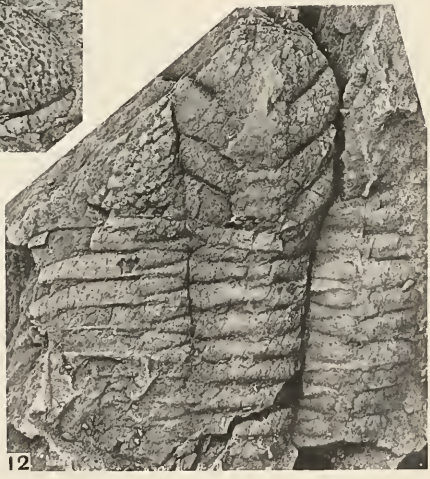
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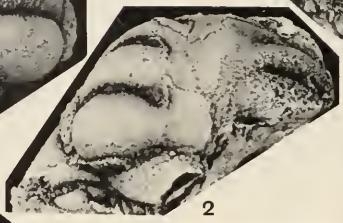
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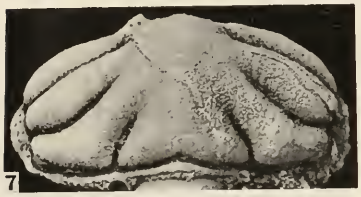
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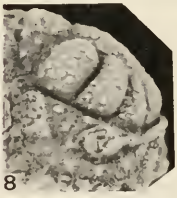
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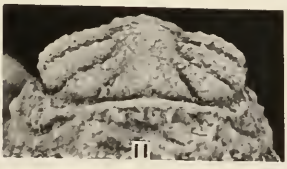
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PLATE 24

Heliomera albata n. sp.

Figure	
1, 4, 5, 7	Glabella of large individual, exterior, dorsal, left lateral, anterior views, X 3. GSC 16258.
2, 3, 6,	Holotype, GSC 16259, incomplete cephalon, dorsal, oblique, left lateral views, X 4½.
8, 11, 12	Small cephalon lacking genal spines, right lateral, anterior, exterior views, X 15. GSC 16260.
9	Smallest cephalon showing left genal spine, exterior view, X 15. GSC 16261.
10, 13	Small incomplete cephalon showing right cheek, exterior, right lateral views, X 9. GSC 16262.

Heliomeroides alacer n. sp.

14, 15, 16	Small incomplete cephalon, right lateral, dorsal, anterior views, X 12. GSC 16264.

PLATE 25

Heliomeroides alacer n. sp.

Figure

1, 2, 4, 5, 6 — Holotype cephalon, GSC 16263, dorsal, anterior, left lateral views, X 6; oblique view of left eye lobe, X 30; oblique view, showing course of sutures, X 10.

Heliomerinid pygidium

3 — External mould of pygidium with some exoskeleton adhering, exterior view, X 6. GSC 16265.

Kawina vulcanus (Billings, 1865)

7, 8 — Lectotype (here selected), GSC 669, original of Billings, 1865, fig. 271a, incomplete cranidium, dorsal, left lateral views, X 2. "Division P, Cow Head."

Kawina limbata n. sp.

9, 11, 12 — Incomplete cranidium, included by Billings in *K. vulcanus*, left lateral, dorsal, anterior views, X 2. GSC 669e, "Division P, Cow Head."

"*Cheirurus*" *polydorus* Billings, 1865

10 — Holotype, GSC 685, incomplete cephalon, dorsal view, X 2. Supposed original of Billings, 1865, p. 286, fig. 274, from Division N, P, Portland Creek.

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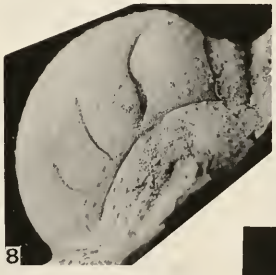
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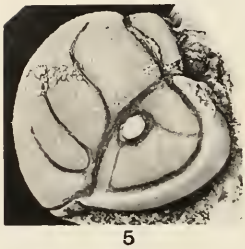
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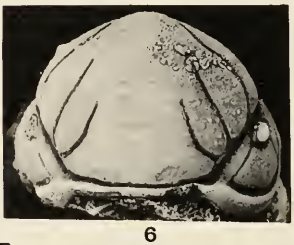
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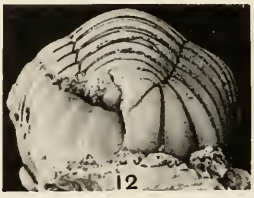
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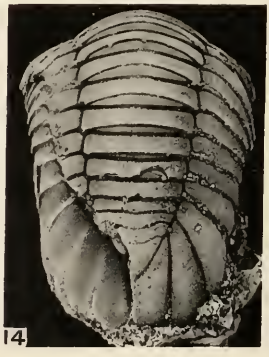
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PLATE 26

Kawina vulcanus (Billings, 1865)

Figure	
1, 2, 3, 13	Cephalon, dorsal, right lateral, anterior views, X 3; ventral view X 4½. GSC 16266.

Kawina limbata n. sp.

4, 5, 6, 10	Holotype, GSC 16267, incomplete cephalon, dorsal, left lateral, anterior, ventral views, X 3.

Kawina arnoldi n. sp.

7-9, 11, 12, 14	Holotype, GSC 16268, partially enrolled exoskeleton, dorsal view of cephalon, left lateral view, anterior view of cephalon, dorsal view of thorax, posterior, dorsal views of thorax and pygidium, X 4½.

PLATE 27

Kawina arnoldi n. sp.

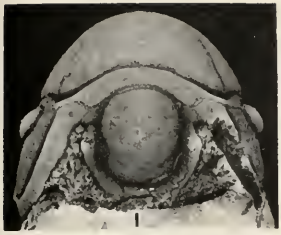
Figure	
1, 4	Incomplete cephalon with hypostome, ventral, right lateral views, X 4½. GSC 16269.
2, 5, 6	Large pygidium, dorsal, posterior, right lateral views, X 2. GSC 16270.
8, 9	Small pygidium, dorsal, right lateral views, X 4½. GSC 16271.

Cydonocephalus griphus n. gen., n. sp.

3, 7, 12, 15, 19	Holotype, GSC 16272, cephalon with hypostome, dorsal, left lateral, oblique, anterior, ventral views, X 8.
10, 11	Cephalon, medium size, dorsal, left lateral views, X 6. GSC 16273.
13, 14	Large cephalon with hypostome, internal mould, dorsal, left lateral views, X 3. GSC 16274.

Cydonocephalus torulus n. gen., n. sp.

16-18	Small cephalon and 5 thoracic segments, dorsal, left lateral, anterior views, X 6. GSC 16275.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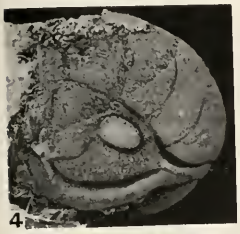
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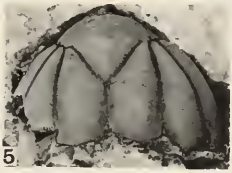
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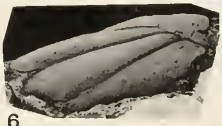
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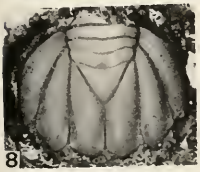
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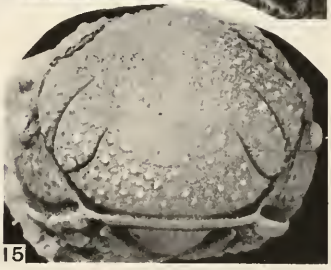
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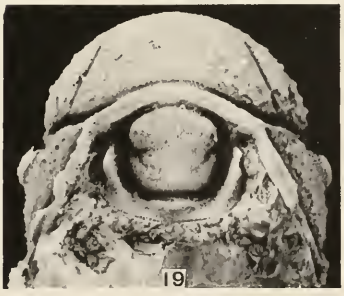
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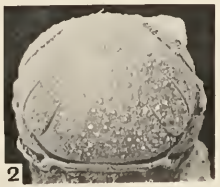
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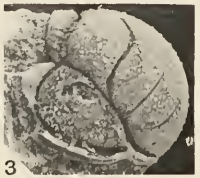
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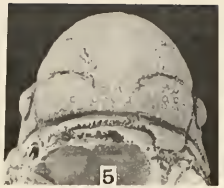
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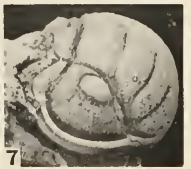
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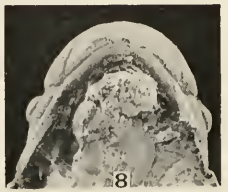
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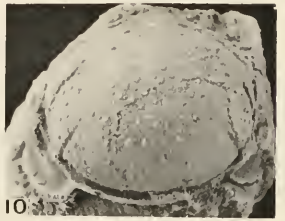
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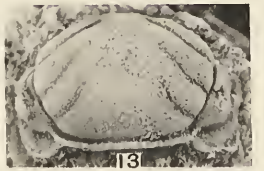
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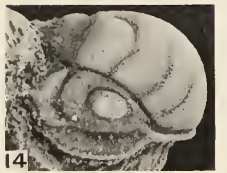
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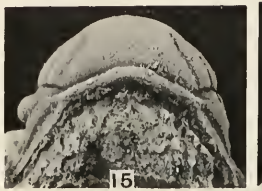
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PLATE 28

Cydonocephalus griphus n. gen., n. sp.

Figure

1-4 Large cephalon, dorsal, anterior, right lateral, oblique views, X 3. GSC 16276.

Cydonocephalus torulus n. sp.

5-8 Cephalon, dorsal, anterior, right lateral, ventral views, X 3. GSC 16278.

Cydonocephalus scrobiculus n. sp.

9-11 Holotype, GSC 16280, cephalon, dorsal, anterior, right lateral views, X 6.

Cydonocephalus prolificus (Billings, 1865)

12-15 Cephalon, dorsal, anterior, right lateral, ventral views, X 4. GSC 16283.

Kawina vulcanus (Billings, 1865)

16-19 Cephalon, dorsal, anterior, right lateral, ventral views, X 3. GSC 16266.

PLATE 29

Cydonocephalus torulus n. gen., n. sp.

Figure	
1-3, 6	Holotype, GSC 16277, cephalon with hypostome, dorsal, anterior, right lateral, ventral views, X 6.
4, 5, 9	Cephalon, dorsal, anterior, right lateral views, X 3. GSC 16279.
7	External surface of eye lobe of original of Pl. 28, figs. 5-8, oblique view, X 20. GSC 16278.

Cydonocephalus scrobiculus n. gen., n. sp.

8, 11, 14	Cephalon, anterior, dorsal, left lateral views, X 6. GSC 16281.
10	External surface of eye lobe of holotype, original of Pl. 28, figs. 9-11, oblique view, X 30. GSC 16280.
12, 13, 15	Small cephalon, anterior, right lateral, dorsal views, X 6. GSC 16282.

Cydonocephalus prolificus (Billings, 1865)

16, 17	Probable holotype, GSC 687, cephalon, original of Billings, 1865, fig. 273, left lateral, dorsal views, X 4, "Division P, Cow Head."

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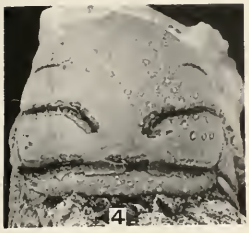
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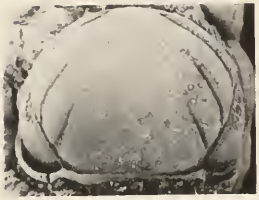
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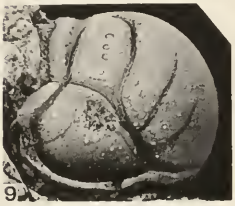
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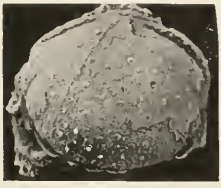
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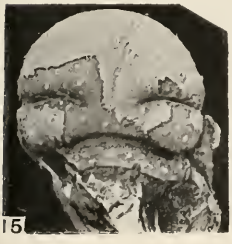
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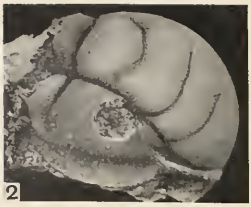
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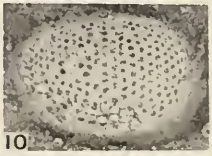
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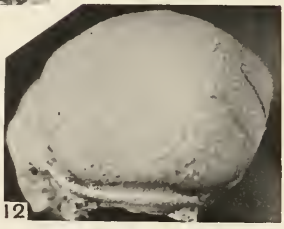
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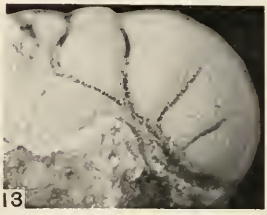
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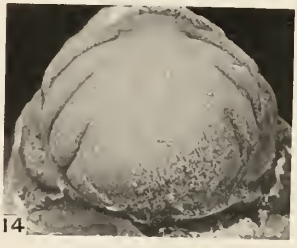
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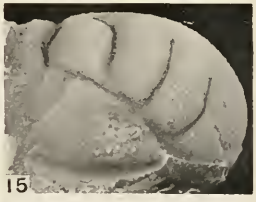
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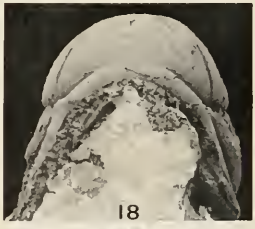
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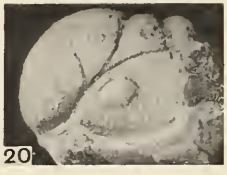
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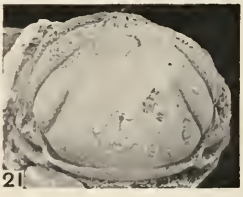
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PLATE 30

Cydonocephalus prolificus (Billings, 1865)

Figure	
1-3	Cephalon, dorsal, right lateral, anterior views, X 4. GSC 16284.
4-6	Small cephalon, dorsal, right lateral, anterior views, X 9, GSC 16285.
7-9	Smallest cephalon, dorsal, left lateral, anterior views, X 9. GSC 16286.
10	External surface of eye lobe of original of Pl. 28, figs. 12-15, oblique view, X 20. GSC 16283.

Cydonocephalus mercurius (Billings, 1865)

11-13	Holotype, GSC 668, incomplete cranidium, original of Billings, 1865, fig. 272, dorsal, anterior, right lateral views, X 4. "Division P, Cow Head."
19, 20	Small cephalon, GSC 668f, included in type lot by Billings, 1865, dorsal, left lateral views, X 4. "Division P, Cow Head."

Cydonocephalus prominulus n. gen., n. sp.

14-16	Holotype, GSC 16287, incomplete cephalon, anterior, right lateral, dorsal views, X 3.
17, 18, 21	Incomplete cephalon, left lateral, ventral, anterior views, X 3. GSC 16288.

PLATE 31

Cheirurid pygidia

? Kawina sp. ind.

Figure

1 Dorsal view, GSC 669b, original of Billings, 1865, fig. 271c, from "Division P, Cow Head," X 2.

2, 6 With thoracic segments, dorsal, posterior views, X 4½. GSC 16289.

3, 7 With thoracic segments, dorsal, right lateral views, X 4½. GSC 16290.

Pygidium gen. ind. 1

4, 5 Dorsal, right lateral views, X 4½. GSC 16291.

8, 9 With thoracic segments, dorsal, left lateral views, X 4½. GSC 16292.

Pygidium gen. ind. 2

10, 11 With thoracic segments, dorsal, left lateral views, X 4½. GSC 16293.

12, 16 Left lateral, dorsal views, X 4½. GSC 16294.

15 Dorsal view, X 4½. GSC 16295.

Pygidium gen. ind. 3

13, 14, 17 With thoracic segments, dorsal, left lateral, posterior views, X 6. GSC 16296.

Pygidium gen. ind. 4

19, 20 With thoracic segments, dorsal, left lateral views, X 4½. GSC 16297.

Ceratocephala exigua n. sp.

18, 21 Holotype, GSC 16298, incomplete cephalon, anterior, exterior views, X 15.

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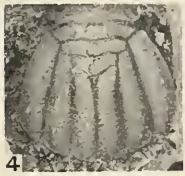
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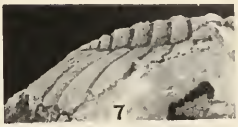
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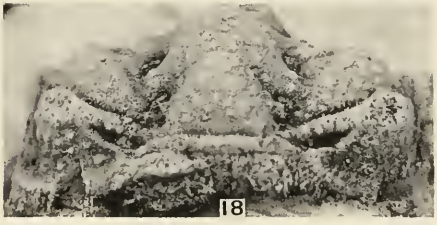
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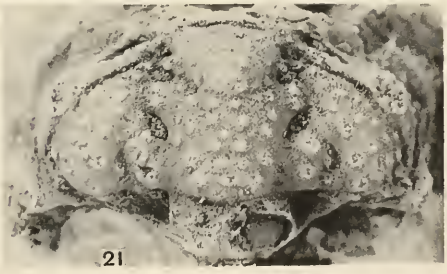
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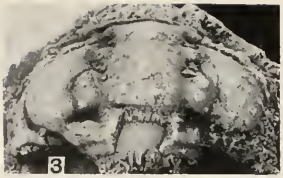
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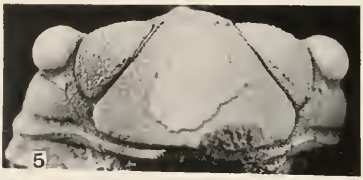
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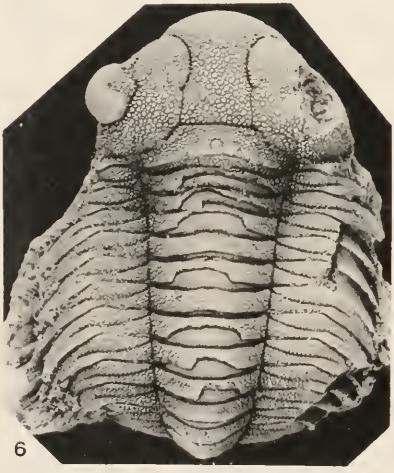
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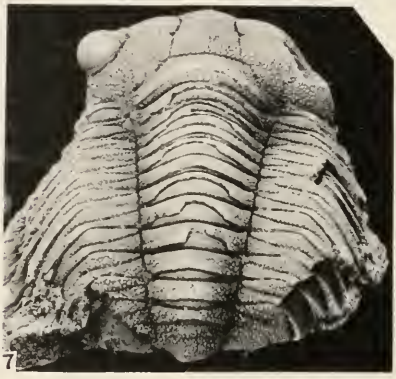
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PLATE 32

Ceratocephala exigua n. sp.

Figure	
1	Holotype, GSC 16298, incomplete cephalon, right lateral view, X 15.
2, 3	Cranidium, oblique, dorsal views, showing posterior band of occipital ring and posterior border, X 9. GSC 16299.

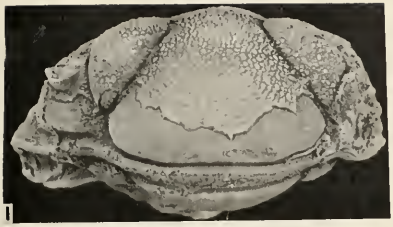
Apatolichas jukesi (Billings, 1865)

4, 5	Holotype, GSC 671a, original of Billings, figs. 269a, 269b, from "Division P, Cow Head"; dorsal, anterior views, X 4.
6, 7, 8	Exoskeleton showing complete thorax and anterior half of pygidium, two dorsal views, right lateral view, X 4½. GSC 16300.
9, 10, 11	Large pygidium, dorsal, right lateral, posterior views, X 4½. GSC 16301.

PLATE 33

Apatolichas jukesi (Billings, 1865)

Figure	
1, 2, 5	Incomplete cephalon with hypostome and first thoracic segment, anterior, oblique, right lateral views, X 4½. GSC 16302.
3, 4	Hypostome, exterior, oblique views, X 6. GSC 16303.
6	Latex cast of interior of hypostome showing doublure, X 4. GSC 16304.
7, 11	Incomplete cephalon, oblique view showing connective suture, X 4½; oblique view of eye lobe, X 30. GSC 16305.
8	Pygidium with pleural regions excavated to reveal part of doublure, which is flexed up sharply at posterior tip of axis, dorsal view, X 6. GSC 16306.
9	Incomplete small pygidium, dorsal view, X 9. GSC 16307.
10	Small pygidium, dorsal view, X 6. GSC 16308.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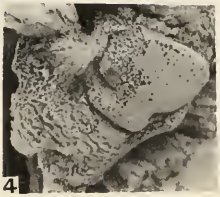
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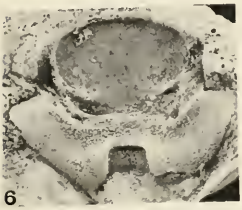
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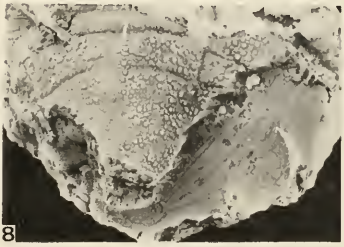
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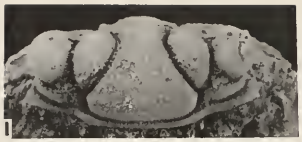
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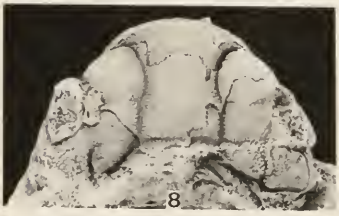
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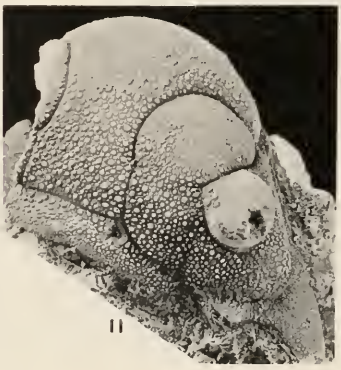
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PLATE 34

Apatolichas fukesi (Billings, 1865)

Figure	
1, 3, 4	Small cephalon and incomplete thorax, anterior, dorsal, left lateral views, X 9. GSC 16309.
2, 5	Internal mould of small cephalon, showing depth of furrows, some thin layers of exoskeleton adhering between furrows, anterior, dorsal views, X 9. GSC 16310.
6	Internal mould of incomplete cephalon, showing depth of furrows in mould, dorsal view, X 6. GSC 16311.
7	Incomplete cephalon, oblique view showing posterior border, X 4½. GSC 16312.
8	Cephalon with some of layers of exoskeleton stripped off, to show difference in appearance of furrows depending on whether or not exoskeleton is present, dorsal view, X 4½. GSC 16313.
9, 11	Incomplete cephalon, two oblique views showing tuberculation, pits and raised lines on external surface, and shape of librigenal spine, X 4½. GSC 16314.
10	Internal mould of incomplete medium-sized cephalon, the glabellar furrows exhibiting their maximum "depth" and development, dorsal view, X 9. GSC 16315.

PLATE 35

Idiorhapha solitaria (Billings, 1865)

Figure

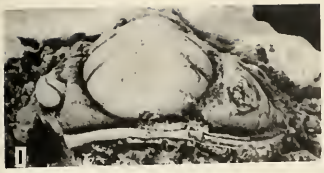
1, 3, 4, 6, 8 — Incomplete cephalon, lacking exoskeleton, anterior, dorsal, left lateral views, X 6; oblique, ventral views, showing anterior branch of suture and doublure, X 9. GSC 16317.

Goniotelus perspicator (Billings, 1865)

2, 5, 7, 9 — Incomplete cephalon lacking exoskeleton, anterior, dorsal, left lateral, ventral views, X 6. GSC 16316.

Perischoclonus capitalis Raymond, 1925

10, 11 — Incomplete cephalon with four thoracic segments articulated, dorsal, right lateral views, X 12. GSC 16318.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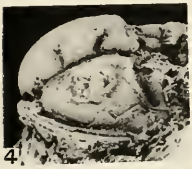
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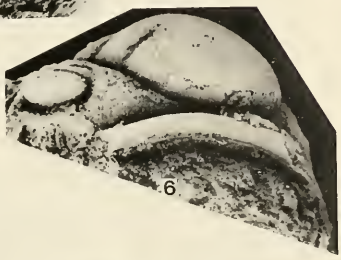
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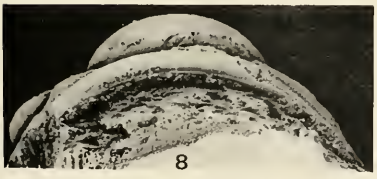
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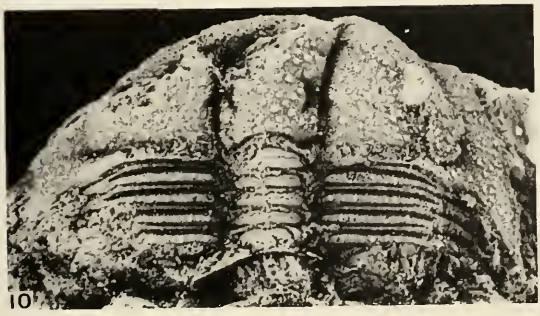
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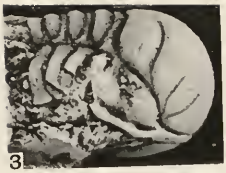
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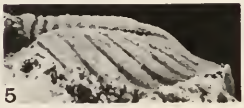
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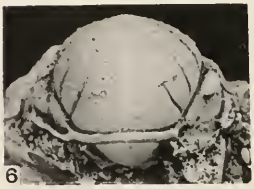
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PLATE 36

Cydonocephalus torulus n. gen., n. sp.

Figure

1-4, 6 Cephalon with three thoracic segments articulated, right free cheek malformed, left lateral, dorsal, right lateral, ventral, anterior views, X 6. GSC 16320.

Perischoclonus capitalis Raymond, 1925

5, 7, 8 Incomplete pygidium, left lateral, dorsal, posterior views, X 6. GSC 16319.

9 Fragment of white limestone from Lower Head, showing abundance of trilobite exoskeletons, X 2.4. Adjacent to "i" are many parts of *Illaenus tumidifrons*, to "b" cephala of *Bathyurellus nitidus*, to right of "s" parts of *Illaenus spiculatus*, and below "t" a cephalon of *Cydonocephalus torulus*.

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AMERICAN SPIDERS OF THE GENERA *AUDIFIA*, *EURYOPIS* AND *DIPOENA* (ARANEAE: THERIDIIDAE)

By Herbert W. Levi

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AMERICAN SPIDERS OF THE GENERA *AUDIFIA*, *EURYOPIS* AND *DIPOENA* (ARANEAE: THERIDIIDAE)

By Herbert W. Levi

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No. 2 — *American Spiders of the Genera* Audifia, Euryopis *and* Dipoena (*Araneae: Theridiidae*)

By Herbert W. Levi

Of the two species placed in *Audifia* by Keyserling in 1884 and Simon in 1894, no specimens other than the female types have been found. Our knowledge of *Audifia* is so limited that we do not even know whether the two species are close to *Euryopis* and *Dipoena*, as is suggested by the presence of four seminal receptacles (Figs. 1, 5).

Dipoena and *Euryopis* are believed to be mainly ant feeders. It is not known how *Dipoena* use their short chelicerae and specialized, flat, saber-like fangs (Levi and Levi, 1962). Some *Dipoena* live on vegetation, others on the ground in debris, making very little use of silk. Although large collections are available from South America, almost none come with information on habitat or habits.

Dipoena and *Euryopis* may represent a separate line in theridiid evolution; all females except a few of *Euryopis* have four seminal receptacles. While related species in theridiids generally have similar coloration, species of *Dipoena* often differ far more in coloration than in genitalic structure. A *Dipoena* key has been constructed, based mainly on coloration; it should be used with caution. Little is known of geographic variation of coloration. Related species differ not only in color, but also sometimes in shape of the abdomen; it may be suboval, triangular, wider than long, or heart-shaped. *Dipoena conica,* with a cone-shaped abdomen (Fig. 143), is close to *D. atlantica* with a subspherical abdomen (Fig. 150). In the majority of *Dipoena* species the carapace of the male is swollen, grooved, or has become a curiously high cylinder with a pattern of grooves on the dorsum. In only a few *Dipoena* species, mostly nearctic, does the male carapace resemble that of the female.

Although large collections of South American *Dipoena* were available, it has to be concluded that these are rare spiders, spotty in distribution. Judging by the occurrence of a new species of *Dipoena* in almost every collection of South American theridiids, our information on the number of species must be very incomplete, and we can expect to find several hundred additional undescribed species of *Dipoena* from tropical South America.

Numerous species are known only from the types, even from such well-collected places as the Panama Canal Zone. Only in Chile is the *Dipoena* fauna limited: only two rare species have been found in the large collections available. Little is known of Argentine *Dipoena*. Most species are found in hotter parts of South America. Not until Dr. Chickering started to work on Panamanian *Dipoena* was the wealth of species recognized. Keyserling, misled by the triangular abdomen of many species, placed such species erroneously into *Euryopis*. These are here transferred to *Dipoena*.

Many species may be endemic or very limited in distribution. Only one species, *D. alta*, is thought to be cosmotropical. One species (*D. prona*) is holarctic in distribution (Map 2).

Unlike *Dipoena*, most species of *Euryopis* are found in the north temperate regions. One species, *E. taczanowskii*, may be cosmotropical (Map 1).

The most important work on American *Dipoena* is that of Chickering (1943, 1948). My own papers (1953, 1954) have illustrated and described North American species. Chickering's species have here been re-illustrated, and the internal female genitalia, often of diagnostic importance, are shown here for the first time. It was difficult, however, to study the ducts of some unique females without removing the epigynum, and this was not done. Another problem was the accumulated debris between various sclerites in the distal end of the palpal bulb. The debris may have come from the disintegration of corks but often it proved impossible to remove from unique type specimens.

I would like to thank the following for making it possible to examine types: Prof. M. Birabén of the Museo de la Plata; Dr. G. Owen Evans, Mr. K. H. Hyatt, Mr. D. Clark of the British Museum (Natural History); Mr. J. Prószyński of the Polish Academy of Sciences; Prof. M. Vachon of the Muséum National d'Histoire Naturelle, Paris; Prof. G. C. Varley of the Hope Department of Entomology, Oxford University; Dr. P. E. Vanzolini and Mr. P. De Biasi, Secretaria da Agricultura, São Paulo; and Profs. G. Wharton and J. N. Knull of Ohio State University. The study would have been impossible without the large collections supplied by the following people: Prof. A. M. Chickering, whose specimens are now housed in the Museum of Comparative Zoology; Dr. W. J. Gertsch from the American Museum of Natural History (AMNH); and Prof. M. Vachon from the unsorted theridiids of the Simon collection in the Muséum

National d'Histoire Naturelle, Paris (MNHN). Mrs. D. Frizzell (Dr. H. Exline) loaned specimens from her personal collection, and with Dr. E. S. Ross, helped to obtain specimens from the California Academy of Sciences (CAS). In addition, Mrs. Frizzell helped with advice on editorial matters. Additional specimens were made available by Mr. R. Dreisbach of Midland, Michigan; Dr. R. X. Schick of San Francisco; Dr. R. D. Barnes of Gettysburg; Dr. J. Cooreman and Mr. J. Kekenbosch of the Institut Royal des Sciences Naturelle, Brussels (ISNB); Dr. O. Kraus of the Senckenberg Museum, Frankfurt am Main (SMF); and Dr. R. V. Chamberlin of the University of Utah (UU).

A National Science Foundation Grant (G-4317) made possible the examination of theridiid types in European museums, and a grant from the National Institutes of Health (E-1944) supported the research. Without this financial assistance it would probably not have been possible to complete this paper.

Audifia Keyserling

Audifia Keyserling, 1884, Die Spinnen Amerikas, Theridiidae, 2(1): 209. Type species by monotypy *A. laevithorax* Keyserling.

Diagnosis. *Audifia* differs from *Euryopis* and *Dipoena* by having an elongate carapace (Fig. 3) (Levi and Levi, 1962).

Comment. The relationship of *Audifia* to other theridiid genera remains unknown as long as no male specimens are available. Both species come from South America.

Audifia laevithorax Keyserling

Figures 1-4

Audifia laevithorax Keyserling, 1884, *op. cit.*, 2(1): 210, pl. 10, fig. 126, ♀. Female type from Para [Belém, Pará, Brazil] in the Muséum National d'Histoire Naturelle, Paris, examined.

Audifia semigranosa Simon

Figures 5, 6

Audifia semigranosa Simon, 1894, Histoire Naturelles des Araignées, 1: 526, figs. 533-535, nom. nudum; 1895, Ann. Soc. Ent. France, p. 132. Female type from Teffe [Tefé], Amazonas, Brazil in the Muséum National d'Histoire Naturelle, Paris, examined.

Euryopis Menge

Euryopis Menge 1868, Shrift. naturf. Gesell. Danzig, n.s., 2: 174. Type species designated by Thorell, 1869, On European Spiders, p. 96, *E. flavomaculata* (C. L. Koch).

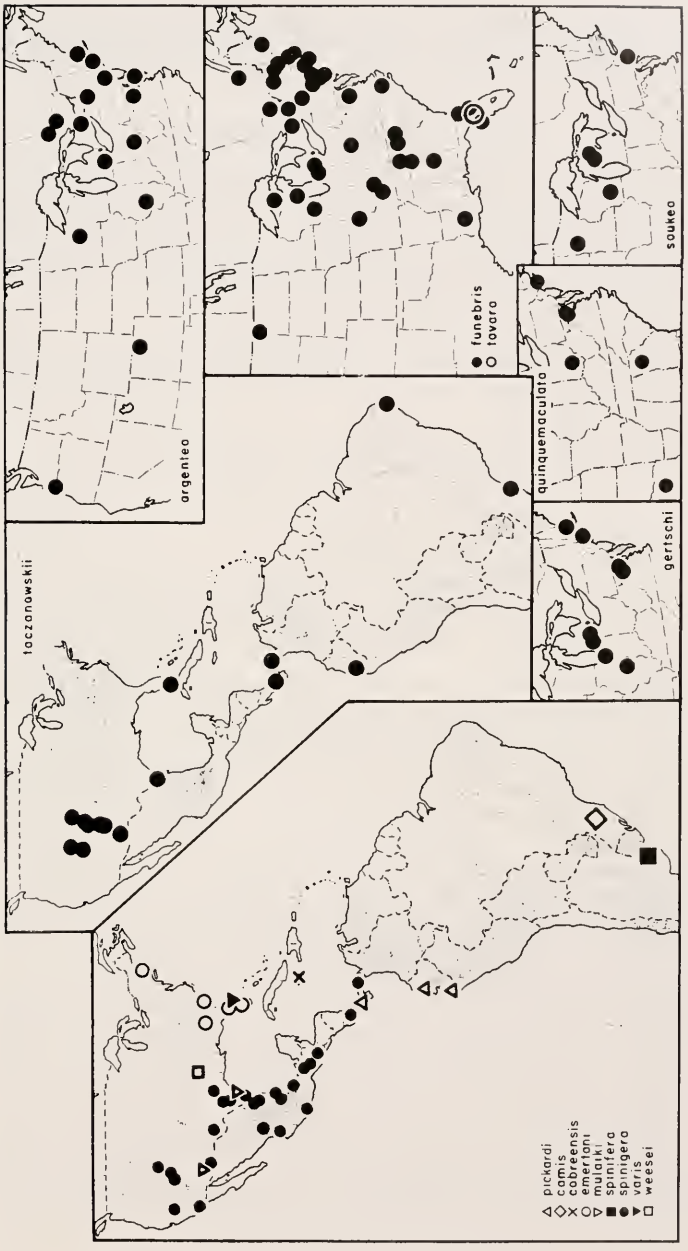
Diagnosis. *Euryopis* usually lacks the two setae in the position of the colulus, that are always present in *Dipoena*. In addition the *Euryopis* palpus lacks a radix and the median apophysis is broadly attached to the bulb, only rarely having a seam. The abdomen is often triangular, as it is in some species of *Dipoena*. The eye region of the carapace is generally small (except *E. taczanowskii*) compared to that of the *Dipoena* species. Only rarely is the shape of the male carapace very different from that of the female (*E. quinquemaculata*), as is common in *Dipoena* (Levi and Levi, 1962).

Distribution. Most species of *Euryopis* are in the north temperate areas; few species in South America. *Euryopis taczanowskii* may be a cosmotropical species (Map 1).

Comments. A puzzling problem is the relationship of the western United States *E. funebris* group of species. It is almost certain that the splitting of this group into numerous species was an error. While it is possible that *E. pepini* Levi, 1954 and *E. coki* Levi, 1954 might be separate species, the others are probably not, although there might be two polytypic species *E. lineatipes* O. P.-Cambridge, 1893 from Alberta to Panama and *E. californica* Banks, 1904 from California to the Gulf coast of Texas. Evidence for my opinion comes from the inability to place more recently collected specimens from the central Rocky Mountains into the described species. The possibility is small that all these recently collected and variable specimens belong to different species. It would be worthwhile to rework this group of *Euryopis* as soon as additional specimens are available and when we know more about their habits. Which of the groups are sympatric? Do sympatric species occur in the same areas and habitats? Do any populations interbreed? Unfortunately, the species are not common.

The following species of *Euryopis* have been transferred to *Dipoena: Euryopis longiventris* Simon; *E. lutea* Keyserling = *D. alta* (Keyserling); *E. maculata* Keyserling = *D. hortoni* Chickering; *E. pumicata* Keyserling; *E. pusilla* Keyserling; *E. variabilis* Keyserling.

Micryphantes gracilis Holmberg, 1872 (An. Agr. Rep. Argentina, 4: 14), the type of which is lost, has been placed by Mello-Leitão in *Euryopis*.



Map 1. Distributions of some species of *Euryopis*.

In the key, references to "Fig." indicate illustrations in this paper, while "1954, fig." indicates that the illustration was published in my previous paper on *Euryopis*.

Key to American *Euryopis*

1a. Palpal cymbium extended beyond alveolus of cymbium (1954, figs. 1-4); epigynum with only two seminal receptacles (1954, figs. 12, 14; Fig. 7) or with four seminal receptacles and openings in sclerotized patch in epigynum (1954, fig. 15); northern United States and Canada 2

1b. Palpal cymbium not extended beyond alveolus; epigynum always with four seminal receptacles, not as in 1954, fig. 15 4

2a. Yellow carapace with a black patch covering clypeus, eye region, and cephalic area (1954, fig. 7); genitalia as in 1954, figs. 4, 11-14; Ontario, Virginia to Oregon *argentea* Emerton

2b. Carapace otherwise 3

3a. Carapace yellow, eyes on black spots (1954, fig. 6); genitalia as in 1954, figs. 6, 15, 16; Massachusetts, Virginia to Michigan *gertschi* Levi

3b. Carapace brown to black (1954, fig. 5); genitalia as in 1954, fig. 2; Figs. 7, 8; New Jersey to Minnesota *saukea* Levi

4a. Carapace wider than long, all eyes appearing large; width of eye region about two-thirds to three-fourths carapace width (1954, figs. 45, 46; Fig. 10); genitalia as in 1954, figs. 38-41, 47-52; Colorado, Florida to Argentina *taczanowskii* Keyserling

4b. Carapace rarely wider than long; width of eye region less than two-thirds (usually less than half) carapace width 5

5a. Abdomen narrow, length one and one-half times width; red-brown with five white spots as in Figure 16; genitalia as in Figures 13-15; New York to Texas *quinquemaculata* Banks

5b. Abdomen usually subtriangular and wider; coloration and genitalia otherwise 6

6a. Abdomen subtriangular; posterior edge with a V-shaped silvery to yellow mark (1954, figs. 129-131) or a triangular gray mark surrounded by silvery border (1954, fig. 132); genitalia as in 1954, figs. 53-64, figs. 83-119; southern Canada to Panama; (*funebris* group) 7

6b. Abdomen, if subtriangular, colored otherwise 9

7a. Papal conductor of male without elbow (1954, figs. 53, 54); anterior seminal receptacles more heavily sclerotized than posterior (1954, fig. 84); Ontario, Quebec, eastern United States to North Dakota, Louisiana and Florida 8

7b. Palpal conductor of male with elbow (1954, figs. 55-64); posterior seminal receptacles more heavily sclerotized than anterior; Wisconsin, British Columbia to Panama *lineatipes* group

8a. Male less than 2.0 mm total length; palpal cymbium almost as wide as long (1954, fig. 54); female unknown, Florida *tavara* Levi

8b. Male more than 2.2 mm total length; width of palpal cymbium three-fourths its length (1954, fig. 53) ..... *funebris* (Hentz)
9a. Females 10
9b. Males 18
10a. Abdomen with transverse bands (Fig. 38); epigynum as in Figure 37; Patagonia ..... *tribulata* Simon
10b. Abdomen colored otherwise 11
11a. Opening of epigynum heavily bordered and circular (Fig. 35); southeastern Brazil ..... *notabila* (Keyserling)
11b. Opening otherwise 12
12a. Heavily bordered opening wider than long (Fig. 31); Panama to Peru *pickardi* sp. n.
12b. Epigynum otherwise 13
13a. A dark spot equal in size to opening and anterior to it (Fig. 18); southern Brazil ..... *camis* sp. n.
13b. Epigynum otherwise 14
14a. Opening wider than long 15
14b. Opening longer than wide 17
15a. Ducts not visible anterior to opening (1954, fig. 25); posterior median eyes one and one-half diameters apart (1954, fig. 35); Florida *varis* sp. n.
15b. Ducts usually visible anterior to opening (1954, fig. 23; Fig. 23); posterior median eyes one diameter or less apart (1954, fig. 30) 16
16a. Usually orange; Utah, Oklahoma, California to Panama *spinigera* O. P.-Cambridge
16b. Blackish brown; Jamaica *cobreensis* sp. n.
17a. Abdomen with symmetrically arranged dorsal light patches (1954, fig. 28); anterior seminal receptacles oval (1954, fig. 18); Texas, Arizona *mulaiki* Levi
17b. Abdomen even-colored or with small spots; anterior seminal receptacles spherical (1954, fig. 20); Massachusetts to Florida, Alabama *emertoni* Bryant
18a. Carapace punctate, without sclerotized plates on abdomen; southeastern Brazil ..... *camis* sp. n.
18b. Carapace smooth, with sclerotized plates on abdomen 19
19a. Ventral, proximal duct loop short and flattened (Figs. 20, 21) 20
19b. Ventral, proximal loop large (Figs. 19, 26, 33) 21
20a. Palpus as in Figure 20; Argentina ..... *spinifera* (Mello-Leitão)
20b. Palpus as in Figure 21; Oklahoma ..... *weesei* sp. n.
21a. Dorsum with sclerotized plates (1954, fig. 27; Fig. 24) 22
21b. Dorsum without sclerotized plates, at most with four sclerotized spots 23
22a. Dorsum with one large sclerotized plate (Fig. 24); Jamaica ..... *cobreensis* sp. n.
22b. Dorsum with one large sclerotized plate and several smaller ones behind (1954, fig. 27); Texas, Arizona *mulaiki* Levi

23a. Ectal duct loop in palpus almost closed (Fig. 29); Utah, Oklahoma, California to Panama ..... *spinigera* O. P.-Cambridge
23b. Ectal duct loop open (Figs. 27, 28, 32) 24
24a. Panama to Peru ..... *pickardi* sp. n.
24b. Eastern United States ..... *emertoni* Bryant

Euryopis saukea Levi

Figures 7-9; Map 1

Euryopis saukea Levi, 1954, Amer. Mus. Novitates, no. 1666: 7, ♂. Male holotype from 5 mi. S of Sauk City, Dane Co., Wisconsin, in the American Museum of Natural History.

Description. Female. Carapace dark brown, black anterior. Sternum black. Legs black except that coxae and proximal two-thirds of femora are white. Abdomen with irregular, triangular, black stripes on silvery dorsum (Fig. 9); sides black; venter between epigynum and spinnerets with silver line which continues anteriorly on each side. Eyes very small, like those of male, subequal in size. Anterior median eyes one and one-half diameters apart, a radius from laterals. Posterior median eyes little more than a diameter apart, one and one-half diameters from laterals. Total length 2.9 mm. Carapace 1.04 mm long, 0.98 mm wide. First patella and tibia 1.04 mm; second 1.05 mm; third 1.04 mm. Fourth femur 1.10 mm; patella and tibia 1.30 mm; metatarsus 1.04 mm; tarsus 0.50 mm.

Record. Michigan. Kalkaska Co.: 23 June 1957, ♀ (R. R. Dreisbach). Otsego Co.: 9 July 1959, ♀ (R. R. Dreisbach).

Euryopis varis sp. n.

Map 1

Euryopis variabilis, — Levi, 1954, *ibid.* p. 23, figs. 25, 26, 35, ♀. Not *Dipoena variabilis* (Keyserling).

Type. Female holotype from Eau Gallie, Brevard County, Florida, 24 Feb. 1936 in the Cornell University collection, currently kept at the American Museum of Natural History. The specific name is an arbitrary combination of letters.

This species was described in my previous paper but was erroneously thought to be the same as Keyserling's species.

Euryopis funebris (Hentz)

?Epeira limbata Walckenaer, 1841, Histoire Naturelles des Insectes Aptères, 2: 81. The type is an unpublished manuscript illustration of Abbot. The specimen from which the drawing was made came from Burke County, Georgia.

Theridion funebre Hentz, 1850, Jour. Boston Soc. Nat. Hist., 6: 277, pl. 9, fig. 11. Type from Alabama lost.

Euryopis funebris, — Emerton, 1882, Trans. Connecticut Acad. Sci., 6: 27, pl. 5, fig. 6, ♀, ♂, and most authors.

Euryopis limbata, — Chamberlin and Ivie, 1944, Bull. Univ. Utah, biol. ser., 8(5): 42. Levi, 1954, Amer. Mus. Novitates, no. 1666: 26, figs. 53, 65, 69, 83, 84, 100, 120, 121, 129, ♀, ♂.

In 1944, Chamberlin and Ivie unfortunately synonymized the names of numerous common American species with those of Walckenaer. Although I followed Chamberlin and Ivie in my previous paper, I have since concluded that many of the synonymies are in error and that others may be arbitrary, as the Abbot drawings to which the names are applied are often not diagnostic (Levi and Levi, 1961). Even though Abbot's drawing bearing Walckenaer's name, *Epeira limbata*, may be the same species as *Euryopis funebris* (Hentz), it is advisable to continue using the latter, long-established name.

Euryopis quinquemaculata Banks

Figures 11-16; Map 1

Euryopis 5-maculata Banks 1900, Canadian Ent., 32: 97. Female syntypes from Washington, D. C., in the Museum of Comparative Zoology, examined.

Dipoena munda Barrows and Ivie, 1942, Ohio Jour. Sci., 42: 20, figs. 1-5, ♀, ♂. Male holotype from Rockbridge, Ohio, at the Ohio State University, examined.

Mufila texana Bryant, 1949, Psyche, 56: 67, fig. 1, ♂. Male holotype from Dallas, Texas, in the Museum of Comparative Zoology. Not *Euryopis texana* Banks, 1908. NEW SYNONYMY.

Euryopis quinquemaculata, — Levi, 1954, Amer. Mus. Novitates, no. 1666: 46, figs. 133-136.

Euryopis bryantae Levi, 1954, *ibid.* p. 47, fig. 137, ♂. New name for *M. texana* Bryant. NEW SYNONYMY.

Note. The late Miss Bryant, who supplied me with a drawing of the male palpus, unfortunately made a mistake and mistook a shadow for a hook; thus the illustration (Levi, 1954, fig. 137) is in error. The type of *Mufila texana* was compared with that of *Dipoena munda* and no significant differences found.

Figures 14-16 were made from the type of *E. quinquemaculata*, Figures 11, 12 from the type of *Dipoena munda*, and Figure 13 from the type of *Mufila texana*.

Distribution. New York, Ohio, Georgia to Texas (Map 1).

Euryopis taczanowskii Keyserling
Figure 10; Map 1

?Phycus brevis O. P.-Cambridge, 1870 [1871], Proc. Zool. Soc. London, p. 742. Juvenile holotype from Ceylon in the Hope Department of Entomology, Oxford University, examined.

Euryopis taczanowskii Keyserling, 1886, Die Spinnen Amerikas, Theridiidae, 2(2): 47, pl. 12, fig. 160, ♀. Female holotype from [Tumbes], Peru, in the Polish Academy of Sciences, Warsaw, examined.

Euryopis floricola Keyserling, 1886, *op. cit.*, 2(2): 261, pl. 21, fig. 309, ♀. Female holotype from Blumenau, [Brazil], in the British Museum, examined. NEW SYNONYMY.

Euryopis nigripes Banks, 1929, Bull. Mus. Comp. Zool., 69: 86. Female holotype from Mt. Hope, Panama Canal Zone in the Museum of Comparative Zoology, examined. — Levi, 1954, Am. Mus. Novitates, no. 1666: 24, figs. 38-52, ♀, ♂. NEW SYNONYMY.

Euryopis dentatus Gertsch and Mulaik, 1936, Am. Mus. Novitates, no. 863: 6, figs. 10, 11, ♀, ♂. Male holotype from Monte Cristo, Texas, in the American Museum of Natural History. NEW SYNONYMY.

Euryopis rosascostai Mello-Leitao, 1944, Rev. Mus. La Plata, n.s., 3: 325, fig. 6. Juvenile holotype from Punta Lara, Provincia de Buenos Aires, Argentina, in the Museo de la Plata, examined. NEW SYNONYMY.

It is possible that this widespread species is cosmopolitan. Unfortunately, O. P.-Cambridge's type from Ceylon is a juvenile and cannot be determined with certainty. A male collected from Hollandia and L. Sentani, New Guinea (Markos, Hart) may belong to this species; the conductor, however, shows differences. The genitalia have been illustrated in my previous paper (Levi, 1954).

Distribution. Utah, Florida, New Mexico to Argentina (Map 1).

Additional Records. Utah. Salt Lake Co.: Little Cottonwood Can., 1500 m, April 1961 (H. Levi, N. Causey). *Central America* (MNHN). *Panama Canal Zone.* Fort Sherman; near Pedro Miguel. *Brazil. Pernambuco:* Recife, ♂ (SMF).

Euryopis camis sp. n.
Figures 17-19; Map 1

Type. Male holotype from Nova Teutonia, lat 27°11′ S, long 52°23′ W, Santa Catarina, Brazil, Nov. 1957 (F. Plaumann) in the Institut Royal des Sciences Naturelles de Belgique, Brussels. The specific name is an arbitrary combination of letters.

Description. Carapace dark brown, sternum brown, legs brown with some indication of darker rings in some specimens; coxae

white. Dorsum of abdomen dark brown with areas around muscle impressions lighter; venter much lighter, almost yellowish. Male carapace heavily sclerotized, finely punctate, quite high with a longitudinal fine black groove in thoracic region, almost one-quarter length of carapace. Sternum smooth. Female carapace low, smooth, without thoracic line. Clypeus fairly straight. Anterior median eyes slightly smaller than others, one and one-half diameters apart, a little less than a diameter from laterals. Posterior median eyes a little more than a diameter apart, a little less than a diameter from laterals. Abdomen of both sexes without scuta, somewhat sclerotized on dorsum, but borders of sclerotized region not sharply delimited. Total length of female 1.7 mm. Carapace 0.64 mm long; 0.52 mm wide; 0.28 mm high. First patella and tibia 0.50 mm; second 0.48 mm; third 0.52 mm. Fourth femur 0.52 mm; patella and tibia 0.70 mm; metatarsus 0.28 mm; tarsus 0.38 mm. Total length of male 1.8 mm. Carapace 0.84 mm long, 0.72 mm wide, 0.48 mm high in thoracic region. First patella and tibia 0.54 mm; second 0.52 mm; third 0.52 mm. Fourth femur 0.59 mm; patella and tibia 0.70 mm; metatarsus 0.34 mm; tarsus 0.36 mm.

Diagnosis. *Euryopis camis* differs from *E. spinifera* in the tip of the embolus and in the different course of the ducts in the palpus (Fig. 19). It differs from *E. pickardi* by the oval posterior pair of seminal receptacles (Fig. 17) and by the male lacking sclerotized plates on the abdomen.

Records. Three ♀ paratypes collected with type; 1 ♀, 1 ♂, paratypes, August 1957 from type locality (ISNB).

Euryopis spinifera (Mello-Leitão), new combination

Figure 20; Map 1

Acanthomysmena spinifera Mello-Leitão, 1944, Rev. Mus. La Plata, n.s., 3: 324, fig. 4. Male holotype from La Plata, Argentina, in the Museo de la Plata, examined.

Comments. This species is close to *E. spinigera* O. P.-Cambridge, found from the southwestern United States to Panama, and to *E. pickardi*, from Panama to Peru. The venter of the abdomen of *E. spinifera* has a series of sclerotized plates, and the structure of the palpus (Fig. 20) differs. It may be the male of *Dipoena micropunctata* Mello-Leitão, 1941, which has only two seminal receptacles and has tentatively been placed in *Pholcomma*.

Record. Argentina. Escoban y Tigre, paratype.

Euryopis weesei sp. n.

Figure 21; Map 1

Euryopis emertoni, — Banks, Newport and Bird, 1932, Univ. Oklahoma Biol. Surv., 4(1): 22. Not *E. emertoni* Bryant.

Type. Male holotype from Wichita National Forest, Comanche County, Oklahoma, 19 June 1928 (E. O. Weese) in the Museum of Comparative Zoology. This species is named after the eminent Oklahoma ecologist Prof. E. O. Weese, who collected the specimen.

Description. Carapace, legs, sternum orange. Abdomen orange-white with sclerotized areas darker orange. Dorsum of abdomen with some black pigment distributed in three transverse lines, a wide anterior line crossing the two anterior sclerotized discs, the two others narrow and just posterior to the posterior sclerotized discs. Also a median longitudinal line from anterior to third transverse line. Posterior of each end of third transverse line are the two dark gray pigment areas. Anterior median eyes slightly larger than others, one diameter apart, almost touching laterals. Posterior eyes their diameter apart. Dorsum of abdomen with four sclerotized discs and strong setae arising from sclerotized spots. Venter of abdomen with plates somewhat like those of *E. emertoni.* A small sclerotized triangular plate on each side of spinnerets. Total length 1.9 mm. Carapace 0.80 mm long, 0.72 mm wide. First patella and tibia 0.59 mm; second 0.63 mm; third 0.67 mm. Fourth femur 0.63 mm; patella and tibia 0.83 mm; metatarsus 0.41 mm; tarsus 0.41 mm.

Diagnosis. Euryopis weesei differs from *E. emertoni* and *E. spinigera* by having a relatively larger palpus and lacking the ectal loop of the duct in the tegulum (Fig. 21).

Euryopis cobreensis sp. n.

Figures 22-26; Map 1

Type. Male holotype from Rio Cobre Gorge, St. Catherine Par., Jamaica, British West Indies, Nov. 1957 (A. M. Chickering) in the Museum of Comparative Zoology.

Description. Carapace dark blackish brown. Sternum olive-brown. Legs brown, tarsi lighter and coxae light. Abdomen dark blackish brown, sclerotized areas more reddish. Abdomen of female almost all black. Eyes of male subequal in size, anterior medians of female slightly larger than others. Anterior median eyes about one diameter apart, touching laterals. Posterior

median eyes one diameter apart, two-thirds diameter from laterals. Total length of female 1.9 mm. Carapace 0.68 mm long, 0.64 mm wide. First patella and tibia 0.60 mm; second 0.60 mm; third 0.56 mm. Fourth femur 0.60 mm; patella and tibia 0.72 mm; metatarsus 0.35 mm; tarsus 0.32 mm. Total length of male 1.7 mm. Carapace 0.72 mm long, 0.62 wide. First patella and tibia 0.60 mm; second 0.52 mm; third 0.60 mm. Fourth femur 0.57 mm; patella and tibia 0.76 mm; metatarsus 0.36 mm; tarsus 0.26 mm.

Diagnosis. The seminal receptacles of the female are lightly sclerotized and punctate (Fig. 22). The opening of the epigynum is wider than that of *E. emertoni* (Fig. 23). The black color separates this species from most specimens of *E. emertoni* and *E. spinigera*. Unlike the other two species, the dorsum of the abdomen of the male has a large sclerotized shield (Fig. 24).

Records. Six ♀ paratypes collected with type.

Euryopis pickardi sp. n.

Figures 30-33; Map 1

Type. Male holotype from Boquete, Panama, 10-25 July 1939 (A. M. Chickering) in the Museum of Comparative Zoology. The species is named after the great araneologist O. Pickard-Cambridge.

Description. Carapace dark brown. Sternum gray. Legs dark brown with coxae light. Abdomen black, sclerotized portions dark brown. General structure and sclerotized plates as in *E. spinigera* O. P.-Cambridge, but carapace slightly lower in male, and male has spines on abdomen slightly heavier and shorter. Eyes subequal in size. Anterior medians one and one-quarter diameters apart, one-quarter from laterals. Posterior eyes a little less than one diameter apart. Total length of female 1.7 mm. Carapace 0.71 mm long, 0.71 mm wide. First patella and tibia 0.65 mm; second 0.65 mm; third 0.68 mm. Fourth femur 0.65 mm; patella and tibia 0.84 mm; metatarsus 0.39 mm; tarsus 0.39 mm. Total length of male 2.0 mm. Carapace 0.78 mm long, 0.73 mm wide. First patella and tibia 0.75 mm; second 0.74 mm; third 0.74 mm. Fourth femur 0.71 mm; patella and tibia 0.92 mm; metatarsus 0.44 mm; tarsus 0.40 mm.

Diagnosis. The dark coloration readily separates this species from *E. spinigera*. The ducts in the male palpus (Figs. 32, 33) run a different course. The female is separated from *E. spinigera* also by the darker coloration and by having a lip framing the opening of the epigynum (Fig. 31).

Comment. It is of interest that one of the commonest theridiid spiders in Central America, *E. spinigera*, has not been collected in Boquete, Panama, a locality in which *E. pickardi* is common. The two species are similar in size and may have the same habits.

Records. Panama: Boquete, 10-25 July 1939, ♀, ♂, paratypes; 1-8 Aug. 1950, ♀, ♂, paratypes; 4-11 Aug. 1954, ♀, ♂, paratypes (all A. M. Chickering). *Jamaica.* Hope Gardens, Kingston, ♂, Dec. 1954 (A. M. Nadler, AMNH). *Ecuador, Manabi:* Guápulo, May 1942 (H. E. Frizzell). *Peru. Piura:* Pariñas Valley, 24 km NE of Negritos, Oct. 1938 (H. E., D. L. Frizzell); N of Mallares, Río Chira, Dec. 1941 (H. E., D. L. Frizzell); Cabo Blanco, Sept. 1941 (R. Walls); Quiroz River, Dec. 1940 (H. E., D. L. Frizzell); Amotape Mts., Jan. 1939 (H. E., D. L. Frizzell).

Euryopis notabila (Keyserling), new combination

Figures 34, 35

Theridium notabile Keyserling, 1891, Die Spinnen Amerikas, Brasilianische Spinnen, 3: 189, pl. 6, fig. 135, ♀. Female type from Serra Vermelha, Est. Rio de Janeiro, Brazil, in the British Museum, examined.

Euryopis tribulata Simon

Figures 36-38

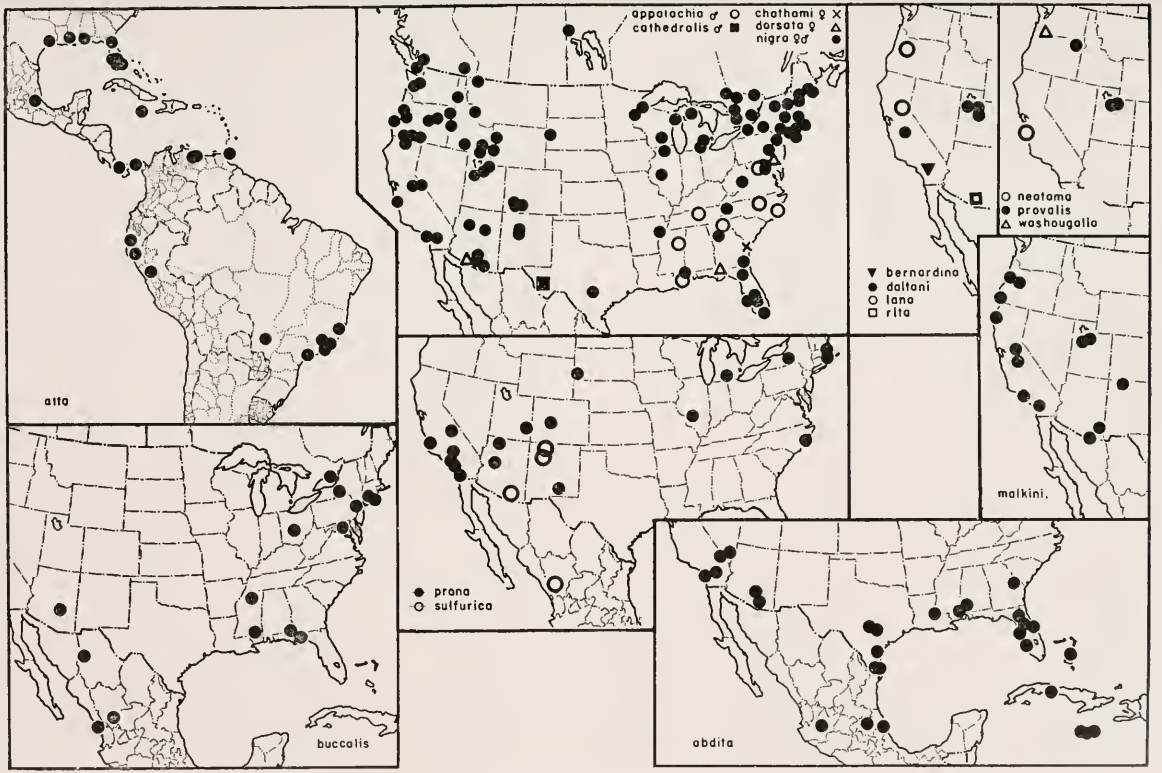
Euryopis tribulata Simon, 1905, Boll. Musei Zool. Anat. Comp. Univ. Torino, 20(511): 6. Female type from Santa Cruz, Patagonia [Argentina], in the Muséum National d'Histoire Naturelle, Paris, examined.

Dipoena Thorell

Dipoena Thorell, 1869, Nova Acta Reg. Soc. Sci. Uppsala (3)7: 91. Type species by original designation *Atea melanogaster* C. L. Koch 1837.

Diagnosis. Dipoena differs from most theridiid genera by having four seminal receptacles. *Dipoena* is distinct from *Euryopis* by having a radix in the male palpus, or if the radix is absent, by having the median apophysis a separate sclerite. Unlike most *Euryopis* species, *Dipoena* species always have two setae replacing colulus. The high carapace of males readily separates many *Dipoena* species, as such a high carapace is unknown in other genera.

Distribution. Most species of *Dipoena* are tropical; a number are found in the north (Map 2) and south temperate regions.



Map 2. Distributions of some species of *Dipoena* found in North America.

One species, *D. alta* Keyserling, may be cosmotropical. Another, *D. prona* (Menge), is holarctic in distribution.

Note. The numerous species of *Dipoena* are often difficult to separate by genitalia. It is interesting, however, that closely related species frequently have entirely different coloration and abdomen shape. Although coloration is of value in separating closely related species in one region, it may be a variable character. While in most theridiid genera the dorsal view of the internal female genitalia is diagnostic or helpful in diagnosing species, in *Dipoena* the ventral view (the cleared epigynum) is of greater value than the dorsal aspect, because the seminal receptacles in dorsal view hide the ducts.

Many species are represented by single individuals only or by a pair of specimens. This lack of material, as well as the diversity and complexity of palpal structure, made it difficult to examine palpal morphology, as is necessary in constructing keys to species. The keys, based mainly on coloration and shape, lead to groups of species usually easily separated by genitalia.

The following species of *Dipoena* have been transferred to other genera:

Dipoena calcarata Simon, 1897 = *Maymena calcarata* (Simon), SYMPHYTOGNATHIDAE

Dipoena cubana Bryant, 1940 = *Thymoites pallidus* (Emerton), NEW COMBINATION

Dipoena micratula Banks, 1909 = *Achaearanea micratula* (Banks), NEW COMBINATION

Dipoena micropunctata Mello-Leitão, 1941 = *Pholcomma micropunctata* (Mello-Leitão), NEW COMBINATION

Dipoena nigerrima Petrunkevitch, 1911 = *Theridula nigerrima* (Petrunkevitch), NEW COMBINATION

Dipoena nigra Keyserling, 1886 = *Theridula nigerrima* (Petrunkevitch, 1911), NEW COMBINATION

Dipoena proba O. P.-Cambridge, 1899 = *Tidarren sisyphoides* (Walckenaer, 1841), NEW SYNONYMY

Dipoena valmonti Simon, 1897 = *Chrosiothes valmonti* (Simon), NEW COMBINATION

The only species to remain unidentified is *D. pulchella* Petrunkevitch, 1925, from Panama. Despite lengthy description it could not be recognized by either Chickering or me. The type specimen cannot be found.

In the key, references to "Fig." indicate illustrations in this paper, while 1935a, fig." and "1953b, fig." indicate that the illustration was published in a previous paper on *Dipoena*.

Key to American Species of *Dipoena*

1a. Abdomen cone-shaped (Fig. 143); Panama, southcentral Brazil ..... *conica* Chickering

1b. Abdomen not cone-shaped 2

2a. Legs with longitudinal black lines 3

2b. Legs banded or unicolor 5

3a. Dorsum of abdomen with a yellowish patch; sides black (Fig. 61); Panama to Paraguay ..... *militaris* Chickering

3b. Abdomen otherwise 4

4a. Abdomen shiny brown but spinnerets yellow; genitalia as in Figures 225-227; Venezuela ..... *tiro* sp. n.

4b. Abdomen black .....
(Figs. 219-222); Nicaragua to British Guiana ..... *cornuta* Chickering
(Figs. 59-64); Central Brazil ..... *militaris* Chickering
(Figs. 131-132); Peru ..... *peruensis* sp. n.
(1953a, figs. 19, 20); Mexico ..... *tecoja* Levi

5a. Abdomen with sclerotized spots (Fig. 302) and palpus as in Figure 303; southeastern Brazil ..... *granulata* (Keyserling)

5b. Abdomen rarely with sclerotized spots and palpus otherwise 6

6a. Palpus with bulb suboval, having its only noticeable sclerites apical as in 1953b, figs. 11-13; Fig. 137; epigynum with a small subcircular posterior opening, anterior to which ducts are visible in V-shape (Figs. 136, 139, 142) 7

6b. Palpus and epigynum otherwise 9

7a. Epigynal opening partly overhung by an anterior sclerite (Fig. 139); palpus with conductor hook-shaped (1953b, figs. 11-13); southern United States to southern Brazil ..... *alta* Keyserling

7b. Epigynal opening otherwise (Figs. 136, 142); palpus with conductor broad (Fig. 137) 8

8a. Epigynum opening bordered all around (Fig. 136); palpus as in Figure 137; Panama ..... *perimenta* sp. n.

8b. Epigynum opening bordered on anterior and sides (Fig. 142); Nicaragua ..... *waspucensis* sp. n.

9a. Carapace, legs yellow and abdomen yellow to gray without distinct marks except in darker orange 10

9b. Coloration otherwise, abdomen all dark gray, brown or black spotted, or patterned 18

10a. Abdomen with darker orange marks (Fig. 285); epigynum opening posterior (Fig. 287); Peru ..... *tingo* sp. n.

10b. Abdomen without such marks; openings of epigynum indistinct 11

11a. Palpus bulb with ventral apophysis (Figs. 103, 104); epigynum as in Figure 101; southern Brazil ..... *plaumanni* sp. n.

11b. Palpus and epigynum otherwise 12

12a. Palpus with two long, longitudinal distal teeth (Fig. 301); abdomen subtriangular; Peru ..... *inca* sp. n.

12b. Palpus, abdomen otherwise 13

13a. Palpus with a prominent ventral hook-like embolus, its base containing winding duct (Fig. 69); female unknown; Panama .. *anas* sp. n.
13b. Palpus otherwise .. 14
14a. Ectal apophysis of palpus crowned by three teeth (1953a, fig. 9); Mexico .. *luisi* Levi
14b. Ectal apophysis with two teeth at most .. 15
15a. Ectal apophysis with a median, mesally directed tooth (Fig. 110); Guatemala .. *crocea* (O. P.-Cambridge)
15b. Ectal apophysis otherwise .. 16
16a. Palpus wider than long (1953a, fig. 10); epigynum opening anterior to seminal receptacles (1953a, figs. 21, 22); Mexico .. *fortunata* Levi
16b. Palpus longer than wide; openings for epigynum near middle of epigynum .. 17
17a. Ectal palpal apophysis with distally pointing hook (1953b, fig. 78); epigynum with two dark spots at lateral ends of depressions (1953b, fig. 108); southern United States; Mexico; West Indies .. *abdita* Gertsch and Mulaik
17b. Ectal apophysis otherwise (1953a, fig. 11; Fig. 109); epigynum with two dark spots anterior to a curved anterior edge of depression (1953a, fig. 23); Costa Rica, Panama .. *josephus* Levi
18a. Abdomen gray, brown, or black without pattern, sometimes with a white spot above spinnerets .. 19
18b. Abdomen with a dorsal pattern or with marks or spots .. 27
19a. Abdomen with a distinct white spot above spinnerets 20
19b. Abdomen without white spot above spinnerets 21
20a. Abdomen higher than long (Figs. 228-231); Trinidad *trinidensis* sp. n.
20b. Abdomen longer than high ..
(Figs. 66, 67); Jamaica .. *bellingeri* sp. n.
(Figs. 268-271); Panama *orvillei* Chickering
(Figs. 74-77); Panama *seclusa* Chickering
21a. Abdomen gray; epigynum as in 1953a, figs. 29, 30; Mexico.. *ocosingo* Levi
21b. Abdomen brown or black; epigynum otherwise .. 22
22a. Dorsum of abdomen shiny .. 23
22b. Dorsum of abdomen dull .. 24
23a. Thorax with a spine (Figs. 205-208); male unknown; Peru .. *spinithorax* (Keyserling)
23b. Thorax without spine ..
(Fig. 244); southern Brazil .. *cordiformis* Keyserling
(Figs. 169, 170); southeastern Brazil.. *obscura* Keyserling
(Figs. 93-95); southeastern Brazil .. *opana* sp. n.
(Figs. 87-89); southern Brazil .. *taeniatipes* Keyserling
24a. Abdomen subtriangular to triangular ..
(Fig. 191-193); Panama, Trinidad .. *bryantae* Chickering
(Figs. 163-168); Panama, Venezuela .. *donaldi* Chickering
(Figs. 297-298); southern Brazil.. *itu* sp. n.
24b. Abdomen oval to spherical .. 25

25a. Epigynum with opening in a sclerotized spot (Fig. 264); palpus as in Figure 265; Costa Rica to Venezuela ..... *banksi* Chickering
25b. Epigynum, palpus otherwise 26
26a. Epigynum with two indistinct dark spots (Fig. 58), southeastern Brazil ..... *flavomaculata* (Keyserling)
26b. Epigynum otherwise .....
(1953b, figs. 23-29); southeastern U. S. ..... *appalachia* Levi
(1953b, figs. 85-86); southeastern U. S. ..... *chathami* Levi
(1953b, figs. 87-88; Fig. 65); Maryland to ?Paraguay ..... *dorsata* Muma
(1953b, figs. 30-32, 37-46, 91-97); southern Canada, U. S. ..... *nigra* (Emerton)
(1953a, figs. 5-8); southern Mexico ..... *origanata* Levi
(1953b, fig. 107); Arizona ..... *rita* Levi
(1953b, figs. 50-59, 105-106); U. S. ..... *prona* (Menge)
(1953a, figs. 19-20); southern Mexico ..... *tecoja* Levi
(1953b, figs. 72-76); Washington ..... *washougalia* Levi
27a. Abdomen white with a black spot above spinnerets; palpus as in 1953a, fig. 3; Panama ..... *chickeringi* Levi
27b. Abdomen and palpus otherwise 28
28a. Abdomen whitish with two spots above spinnerets .....
(Figs. 122-124); Panama ..... *mertoni* sp. n.
(Figs. 70-73); Panama ..... *proterva* Chickering
28b. Abdomen otherwise 29
29a. Abdomen dark gray to black with two longitudinal rows of white patches 30
29b. Abdomen colored otherwise 31
30a. Abdomen widest behind middle; western North America .....
(Figs. 125-127); California ..... *bernardino* sp. n.
(1953b, figs. 65-71, 116-117); Utah ..... *daltoni* Levi
(1953b, figs. 112-113; Figs. 128-130); Oregon, California, ?Panama ..... *lana* Levi
(1953b, figs. 8, 60-64, 110-111); Pacific Coast, southwestern U.S. ..... *malkini* Levi
(1953b, figs. 7, 118-119); California ..... *neotoma* Levi
(1953b, figs. 114-115); Utah, Oregon ..... *provalis* Levi
30b. Abdomen oval, widest in middle .....
(Figs. 39-43); Panama, Venezuela ..... *balboae* Chickering
(Figs. 281-284); Panama ..... *isthmia* Chickering
31a. Abdomen whitish; venter of abdomen black anterior to spinnerets 32
31b. Abdomen otherwise 33
32a. Abdomen longer than wide; epigynum as in Figure 118; Panama ..... *venusta* Chickering
32b. Abdomen wider than long, epigynum as in Figure 121; Peru ..... *esra* sp. n.
33a. Venter of abdomen black with two white patches anterior to pedicel (Fig. 288); epigynum as in Figure 291; Peru ..... *pallisteri* sp. n.
33b. Abdomen, epigynum otherwise 34

34a. Abdomen purplish with two rows of light spots (Fig. 187); epigynum and palpus as in Figure 190; Panama to southern Brazil ..... *rubellum* (Keyserling)
34b. Abdomen otherwise 35
35a. Venter of abdomen with a discrete white spot in black area (1953b, fig. 5); New Mexico ..... *sulfurica* Levi
35b. Venter of abdomen otherwise 36
36a. Abdomen wider than long 37
36b. Abdomen longer than wide, sometimes spherical or subtriangular 39
37a. Carapace brown to black .....
(Figs. 250-253); Panama, Brazil ..... *hortoni* Chickering
(Figs. 78-80); Panama ..... *parki* Chickering
(Figs. 87-89); southern Brazil ..... *taeniatipes* Keyserling
(Figs. 147-149); Peru, ?Venezuela ..... *woytkowskii* sp. n.
37b. Carapace white or yellowish 38
38a. Clypeus with black marks .....
(Figs. 194-198); southern Brazil ..... *santacatarinae* sp. n.
(Figs. 181-182); southeastern Brazil ..... *niteroi* sp. n.
(Figs. 272-276); Jamaica, Panama ..... *pacifica* Chickering
38b. Clypeus without black marks .....
(Figs. 254-256); Venezuela ..... *augara* sp. n.
(Figs. 235-237); southern Brazil ..... *ira,* sp. n.
(Figs. 155-159); Panama ..... *standleyi* sp. n.
39a. A black band from clypeus to thoracic region; (Figs. 248-249); southeastern Brazil ..... *sicki* sp. n.
39b. Coloration otherwise 40
40a. Abdomen dorsum black with a white band outlining a median black square and white lines radiating towards sides .....
(Figs 150-154); Panama to Paraguay ..... *atlantica* Chickering
(Figs. 242-243); southeastern Brazil ..... *keyserlingi* nom. nov.
(Figs. 160-162); southern Brazil ..... *pusilla* (Keyserling)
40b. Coloration otherwise 41
41a. Carapace white or yellow, without pigment 42
41b. Carapace gray-brown to black, pigmented 43
42a. Abdomen subtriangular or pointed behind .....
(Figs. 232-234); Panama ..... *barro* sp. n.
(Figs. 238-241); Panama, Venezuela ... *duodecimpunctata* Chickering
42b. Abdomen suboval to spherical .....
(Figs. 171-173); northern Mexico ..... *anahuas* sp. n.
(Figs. 199-204); Bahama Isl. ..... *bimini* sp. n.
(Figs. 183-184); Mexico to Panama ..... *superba* Chickering
43a. Female carapace highest in thoracic region .....
(1953b, figs. 6, 16-18, 33-34, 98-101); eastern, southwestern U. S. to Mexico ..... *buccalis* Keyserling
(1953a, figs. 14, 15, 27, 28); Costa Rica to Brazil ..... *copiosa* Levi
43b. Female carapace not elevated behind eyes 44

44a. United States and northern Mexico
(1953b, figs. 6, 16-18, 33-34, 98-101); eastern, southwestern U. S. *buccalis* Keyserling
(1953b, figs. 19-22); Texas *cathedralis* Levi
44b. West Indies, Central and South America 45
45a. Abdomen subtriangular or pointed behind
(Figs. 163-168); Panama, Venezuela *donaldi* Chickering
(Figs. 174-177); Mexico to Panama *insulana* Chickering
(Figs. 114-115); Argentina *longiventris* (Simon)
(Figs. 185-186); southern Brazil *variabilis* (Keyserling)
45b. Abdomen suboval to spherical 46
46a. Dorsum of abdomen mottled in appearance and darker in longitudinal median band than on sides
(Figs. 266-267); Panama *bequaerti* Chickering
(Figs. 44-45); Panama *boquete* sp. n.
(Figs. 46-52); Chile *chillana* sp. n.
(Figs. 292-296); southern Brazil *foliata* Keyserling
(Figs. 277-280); Jamaica *liguanca* sp. n.
(Figs. 84-86); West Indies, Mato Grosso *morosa* Bryant
(Figs. 53-55); Chile *ohigginsi* sp. n.
(Figs. 178-180); Puerto Rico *puertoricensis* sp. n.
46b. Dorsum of abdomen otherwise 47
47a. Dorsum of abdomen with symmetrical white or light patches or lines
(Figs. 81-83); Chiapas, Panama *catoni* Chickering
(Figs. 174-177); Mexico to Panama *insulana* Chickering
(Figs. 105-108); Venezuela, British Guiana *kuyuwini* sp. n.
(Figs. 90-92); Amazon *olivenea* sp. n.
(Figs. 209-218); Brazil *pumicata* (Keyserling)
(Figs. 160-162); southern Brazil *pusilla* (Keyserling)
(Figs. 96-98); Panama *zeteki* Chickering
47b. Dorsum of abdomen otherwise
(Figs. 111-113); Bolivia *beni* sp. n.
(Figs. 250-253); Panama, eastern Brazil *hortoni* Chickering
(Figs. 257-258); Lesser Antilles *meckeli* Simon
(Figs. 259-262); Panama *tropica* Chickering

Dipoena nigra (Emerton)

Map 2

Steatoda nigra Emerton, 1882, Trans. Connecticut Acad. Sci., 6:21, pl. 4, fig. 4, ♀. Female syntypes from Portland, Maine, and Beverly and Holyoke, Massachusetts, in the Museum of Comparative Zoology.

Dipoena nigra, — Banks, 1892, Proc. Acad. Nat. Sci. Philadelphia, p. 31. — Levi, 1953, Amer. Mus. Novitates, no. 1647: 21, figs. 30-32, 37-46, 91-97 ♀, ♂.

Dipoena parvula Banks, 1901, Proc. U.S. Natl. Mus., 23: 589, fig. 4, ♀. Female holotype from Catalina Springs [?], Arizona, in the United States National Museum, examined. NEW SYNONYMY.

Distribution. Southern Canada and all parts of the United States.

Additional Records. Arizona. Cochise Co.: Upper Carr Can., Huachuca Mts. Pima Co.: Marana, in alfalfa (G. Butler). *California.* Mono Co.: Montgomery Can., July 1941 (W. M. Pearce). Riverside Co.: Idyllwild, July 1953 (W. J., J. W. Gertsch).

Dipoena appalachia Levi

Map 2

Dipoena appalachia Levi, 1953, Amer. Mus. Novitates, no. 1647: 19, figs. 23-29, ♀, ♂. Male holotype from Beaufort, North Carolina, in the American Museum of Natural History.

Note. The female of this species is unknown; it may have been confused with *D. nigra.*

Distribution. Southeastern states.

Additional Record. North Carolina. Durham Co.: Duke Forest, July 1953 (R. D. Barnes).

Dipoena dorsata Muma

Figure 65; Map 2

Dipoena dorsata Muma, 1944, Amer. Mus. Novitates, no. 1257: 6, fig. 8, ♀. Female type from Churchville, Maryland, in the American Museum of Natural History. — Levi, 1953, *ibid.*, no. 1647: 17, figs. 87-88, ♀.

It is not certain that all the specimens examined belong to this species. The internal genitalia seem to be alike, but because of heavy pigment, they are difficult to see. A *Dipoena* from Paraguay has similar genitalia, but has a modified carapace, very high in the thoracic region, sloping down to the eyes. Though it is almost certainly a different species, it was not described as new because of lack of differential characters.

Distribution. Maryland, Florida, Arizona to ?Paraguay. (Only United States records are shown on Map 2.)

Additional Records. Arizona. Santa Cruz Co.: Madera Canyon, Santa Rita Mts. (W. J. Gertsch, AMNH). *Panama Canal Zone:* Summit (A. M. Chickering); Barro Colorado Isl. (A. M. Chickering). *Paraguay:* Taguararapa, Alto-Parana, doubtful determination (AMNH).

Dipoena buccalis Keyserling
Map 2

Dipoena buccalis Keyserling, 1886, Die Spinnen Amerikas, Theridiidae, 2(2): 42, pl. 12, fig. 157, ♀. The syntypes came from "Philadelphia, Fortress Monroe and Atlantic City" collected by Marx. A specimen designated paratype and labelled as coming from Fort Monroe, Virginia, is in the United States National Museum. — Levi, 1953, Amer. Mus. Novitates, no. 1647: 27, figs. 6, 16-18, 33-34, 98-101, ♀, ♂.

Note. Southern females of this species have the carapace high in the center (1953b, fig. 101). It is very high in Mexican specimens and in the single female from Arizona. The Arizona specimen first recorded here has the epigynal depression quite narrow; however, the openings and the posterior sclerotized piece are in the usual position.

Distribution. Southern Ontario, eastern United States from Connecticut, Ohio to Alabama, Arizona and Sonora, Durango, Mexico (Map 2).

Additional Records. Florida. Leon Co.: Tallahassee, Aug. 1903 (A. P. Morse). *Ohio.* ?Franklin Co.: "Flint Ravine, 82° W 39° N Aug. 1922," ♀ (W. M. Barrows, UU). *Arizona.* Maricopa Co.: 8 mi. N of Roosevelt Dam, Apr. 1935, ♀ (W. Ivie, UU).

Dipoena sulfurica Levi
Map 2

Dipoena sulfurica Levi, 1953, Amer. Mus. Novitates, no. 1647: 29, figs. 4-5, 47-49, 83-84, 102-104. Male holotype from 10 mi. E of El Salto, Durango, Mexico, in the American Museum of Natural History.

Distribution. New Mexico, Arizona to Durango (Map 2).

Additional Records. Arizona. Pima Co.: Mt. Lemmon, Santa Catalina Mts., Sept. 1939, ♀ (R. H. Crandall).

Dipoena prona (Menge)
Map 2

Pachydactylus pronus Menge, 1868, Schrift. naturf. Gesell. Danzig, 2: 177, pl. 33, fig. 80. Female type from Weichselmünde forest near Danzig.

Dipoena hamata Tullgren, 1949, Ent. Tidskrift, 70: 50, figs. 10, 11, ♂. Male holotype from St. Karlsö, Sweden, in the Natural History Museum, Stockholm. — Levi, 1953, Amer. Mus. Novitates, no. 1647: 30, figs. 50-59, 105-106, ♀, ♂.

Comment. Several letters were received from European colleagues after the publication of my previous *Dipoena* paper, telling me that *D. hamata* is a synonym of *D. prona* (Menge).

Natural History. A female and male specimen were found under boards in a meadow at 2900 m altitude in Colorado.

Distribution. Northern Europe and in all parts of the United States (Map 2).

Additional Record. Colorado. Gunnison Co.: 4 mi. S of Gothic, 5 June 1959, ♀, ♂ (H., L. Levi).

Dipoena daltoni Levi

Map 2

Dipoena daltoni Levi, 1953, Amer. Mus. Novitates, no. 1647: 35, figs. 65-71, 116-117, ♀, ♂. Female holotype from Dalton Creek, Fresno Co., California, 1500 m alt., in the American Museum of Natural History.

Natural History. Specimens of this species were collected by sifting lombardy poplar (*Populus nigra* Linnaeus) litter in Grantsville, Utah, in April, 1961.

Distribution. Utah, California (Map 2).

Additional Record. Utah. Tooele Co.: Grantsville, April, 1961 (H. Levi).

Dipoena malkini Levi

Map 2

Dipoena malkini Levi, 1953, Amer. Mus. Novitates, no. 1647: 33, figs. 8, 60-64, 110-111, ♀, ♂. Male holotype from Rogue River, Curry County, Oregon, in the American Museum of Natural History.

Distribution. Western United States; Utah, Oregon to New Mexico and California (Map 2).

Additional Records. California. Humboldt Co.: Holmes, Avenue of Giants Redwood Forest, ♀. Ventura Co.: 15 mi. S of Oxnard, July 1953, ♀ (W. J., J. W. Gertsch).

Dipoena lana Levi

Figures 128-130; Map 2

Dipoena lana Levi, 1953, Amer. Mus. Novitates, no. 1647: 36, figs. 112-113, ♀. Female holotype from Lane County, Oregon, in the American Museum of Natural History.

Specimens from Panama may belong to this species although slightly smaller, lack spots on the abdomen, and have slightly

different eye arrangement, the posterior medians being slightly closer to each other than to laterals. The Panamanian record is not included on the map.

Distribution. Oregon, California (Map 2).

Records. Panama: Boquete, Aug. 1950 (A. M. Chickering).

Dipoena bernardino sp. n.

Figures 125-127; Map 2

Type. Female holotype from Old Baldy, San Bernardino Mountains, San Bernardino County, California, 7 May 1936, in the Cornell University Collection and at present stored in the American Museum of Natural History. The specific name is a noun in apposition after the type locality.

Description. Carapace, sternum, legs yellow. Dorsum of abdomen gray with several paired white spots (Fig. 125); venter lighter gray. Carapace low. Eyes subequal in size. Anterior median eyes a little more than their diameter apart, almost touching laterals. Posterior eyes two-thirds diameter apart. Abdomen widest posteriorly. Total length 2.2 mm. Carapace 0.84 mm long, 0.73 mm wide, 0.39 mm high. First patella and tibia 0.91 mm; second 0.78 mm; third 0.73 mm. Fourth femur 0.95 mm; patella and tibia 1.10 mm; metatarsus 0.62 mm; tarsus 0.39 mm.

Diagnosis. This species differs from *D. daltoni* by the shape of the epigynum (Fig. 127) and the internal genitalia (Fig. 126).

Dipoena abdita Gertsch and Mulaik

Map 2

Dipoena abdita Gertsch and Mulaik 1936, Amer. Mus. Novitates, no. 863: 6, fig. 28, ♀. Female holotype from Edinburg, Texas, in the American Museum of Natural History. — Levi, 1953, Amer. Mus. Novitates, no. 1647: 37, figs. 77-82, 108-109, ♀, ♂.

Distribution. Gulf States to California, South to Veracruz, Lesser Antilles (Map 2).

Additional Records. California. Inyo Co.: Chicago Valley, Resting Springs (J. N. Belkin). Riverside Co.: Coachella Valley (R. X. Schick). *Cuba.* Villas: Soledad (C. T. Parsons). *Jamaica:* Mona, St. Andrew Par.; 1 mi. E of Golden Grove, St. Thomas Par.; Christiana, Manchester Par.

Dipoena josephus Levi
Figure 109

Dipoena josephus Levi, 1953, Amer. Mus. Novitates, no. 1639: 6, figs. 11-13, 23-24, ♀, ♂. Male holotype from San José, Costa Rica, in the American Museum of Natural History.

Figure 109 was drawn at a slightly different angle than the previous illustration (1953, fig. 11).

Additional Records. Costa Rica. Turrialba (B. Malkin, AMNH). *Panama:* Boquete; Barro Colorado Isl. (A. M. Chickering).

Dipoena crocea (O. P.-Cambridge)
Figure 110

Achaea crocea O. P.-Cambridge. 1896. Biologia Centrali-Americana. Araneidea, 1: 210, pl. 26, fig. 11, ♂. Male holotype from Cubilguitz, [18 km N of Cobán, Alta Verapaz], Guatemala, in the British Museum, examined.

Dipoena crocea, — Levi, 1953, Amer. Mus. Novitates, no. 1639: 8.

This species is close to *D. abdita.* The carapace of the male is low and the whole spider is yellow.

Dipoena tecoja Levi

Dipoena tecoja Levi, 1953, Amer. Mus. Novitates, no. 1639: 10, figs. 19, 20, ♀. Female [not male] holotype from Tecoja, Chiapas, Mexico, in the American Museum of Natural History.

Dipoena balboae Chickering
Figures 39-43

Dipoena balboae Chickering, 1943, Trans. Amer. Micros. Soc., 62: 334, figs. 6-9, ♀, ♂. Male holotype from Balboa, Panama Canal Zone, in the Museum of Comparative Zoology, examined.

Comments. The palpus of the type is slightly expanded (Fig. 43). This species is very similar to *D. nigra* and may be the same. It is lighter in coloration (Fig. 39), and the male has shorter first legs. The genitalic differences are a longer cone-shaped base of the embolus (Fig. 43) and shorter female connecting ducts (Fig. 40). The base of the embolus of *D. nigra* is spherical (1953b, figs. 30-32).

Additional Records. Panama: Arraiján, ♀ (A. M. Chickering). *Venezuela. Carabobo:* Valencia, ♂ (MNHN).

Dipoena boquete sp. n.

Figures 44-45

Type. Male holotype from Boquete, Panama, 1-8 Aug. 1950 (A. M. Chickering), in the Museum of Comparative Zoology. The specific name is a noun in apposition after the type locality.

Description. Carapace black, legs yellow. Dorsum of abdomen spotted black and white (Fig. 44); venter gray. Carapace slightly higher behind eyes. Diameter of anterior median eyes almost twice that of other eyes. Anterior median eyes their diameter apart, touching laterals. Posterior median eyes their diameter apart, their radius from laterals. Tooth length 1.6 mm. Carapace 0.65 mm long, 0.62 mm wide, 0.52 mm high. First femur 0.68 mm; patella and tibia 0.72 mm; metatarsus 0.43 mm; tarsus 0.27 mm. Second patella and tibia 0.59 mm; third 0.52 mm; fourth 0.69 mm.

Diagnosis. The winding of the palpal duct, and the shape of conductor and embolus (Fig. 45) separate this species from *D. balboae.* Like *D. balboae, D. boquete* belongs to the *D. nigra* group, but unlike others of this group, the abdomen is spotted (Fig. 44).

Dipoena chillana sp. n.

Figures 46-52

Type. Male holotype from Fundo Malcho, Cordillera Parral, Linares, Chile, Dec. 1957 (L. Peña) in the Institut Royal des Sciences Naturelles de Belgique, Brussels. The species is named after Sierra Chillan, a place of its occurrence.

Description. Carapace, sternum, legs dusky brown. Dorsum of abdomen black with gray and white pattern (Fig. 47); venter dark gray without pattern or marks. One specimen almost lacks the pattern and white pigment. Carapace of male low (Fig. 46). Eyes subequal in size or anterior median eyes slightly smaller than others. Anterior medians a little more than their diameter apart, almost touching laterals. Posterior medians their radius apart, one diameter from laterals. Total length of females 1.9-3.2 mm. Total length of one female 1.9 mm. Carapace 0.85 mm long, 0.75 mm wide. First patella and tibia 1.04 mm; second 0.75 mm; third 0.65 mm. Fourth femur 0.91 mm; patella and tibia 1.04 mm; metatarsus 0.64 mm; tarsus 0.35 mm. Total length of male 1.5 mm. Carapace 0.69 mm long, 0.65 mm wide. First femur 1.17 mm; patella and tibia 1.06 mm; metatarsus 0.80 mm;

tarsus 0.37 mm. Second patella and tibia 0.78 mm; third 0.58 mm.

Diagnosis. This species is close to *Dipoena nigra* (Emerton). It differs by having a dorsal abdominal pattern, a loop of the embolus at the distal tip of the palpus (Fig. 52), and a different epigynum. The epigynum is quite indistinct and is variable in appearance. It is usually covered by some exudate that, when removed, may take some of the integument along with it. Although the epigynum is variable, the center is usually the lightest portion; this light portion is in a slight depression. When cleared in clove oil the sclerotized ends of the ducts show up (Figs. 48, 50), and all specimens look alike.

Records. Chile. Linares: Fundo Malcho, Cord. Parral, Dec. 1957, Feb. 1958, March 1958 ♀, ♂ paratypes (L. Peña, ISNB). *Nuble:* Sierra de Chillán, ♀ (?Germain, MNHN).

Dipoena ohigginsi sp. n.

Figures 53-55

Type. Female holotype from La Leonera, 800-1000 m, 30-40 km NE of Rancagua, O'Higgins, Chile, 28 Dec. 1954 (L. Peña), in the Institut Royal des Sciences Naturelles de Belgique, Brussels. This species is named after Bernardo O'Higgins, first president of the Chilean republic.

Description. Carapace, legs, sternum brown. Dorsum of abdomen grayish brown with an indistinct pattern (Fig. 53). Venter of abdomen lighter brown. Anterior median eyes slightly larger than others. Posterior median eyes oval, their longer diameter at right angles to carapace axis. Anterior median eyes one diameter apart, almost touching laterals. Posterior median eyes their radius apart, their longer diameter from laterals. Total length 3.0 mm. Carapace 1.05 mm long, 0.90 mm wide. First femur 1.40 mm; patella and tibia 1.39 mm; metatarsus 1.01 mm; tarsus 0.44 mm. Second patella and tibia 1.05 mm; third 0.71 mm; fourth 1.26 mm.

Diagnosis. Dipoena ohigginsi can be separated from *D. chillana,* the only other Chilean *Dipoena,* by the very large bordered depression of the epigynum (Fig. 55).

Dipoena flavomaculata (Keyserling)

Figures 57-58

Heribertus flavomaculatus Keyserling, 1891, Die Spinnen Amerikas, Brasilianische Spinnen, 3: 223, pl. 9, fig. 164, ♀. Female holotype from Serra Vermelha, [Est. Rio de Janeiro], Brazil, in the British Museum, examined.

Umfila flavomaculata, — Petrunkevitch, 1911, Bull. Amer. Mus. Nat. Hist., 29: 214.

The cephalothorax is red-brown, the abdomen black with lighter depressions.

Dipoena militaris Chickering

Figures 59-64

? Dipoena striatipes Simon, 1894, Histoire Naturelle des Araignées, 1: 564, fig. 574, ♂, *nomen nudum.*

Dipoena militaris Chickering, 1943, Trans. Amer. Micros. Soc., 62: 358, figs. 42, 43, ♀. Female holotype from Randolph Field, Panama Canal Zone, in the Museum of Comparative Zoology, examined.

Dipoena matogrossensis Soares and Camargo, 1948, Bol. Mus. Paraense E. Goeldi, 10: 366, figs. 19, 20, ♂. Male holotype from Chavantina, Mato Grosso, Brazil, in the Departamento de Zoologia da Secretaria da Agricultura do Estado de São Paulo, examined. NEW SYNONYMY.

Carapace dark brown, sternum dusky, legs yellow with a fine black prolateral line. Abdomen in some specimens with sides black (Fig. 61), a dusky median dorsal band and venter dark gray.

Note. Simon (1894) figured the lateral view of a male carapace and chelicerae of a species called *Dipoena striatipes;* no locality is given. In the Muséum National d'Histoire Naturelle is a female specimen of *D. militaris* Chickering from Rio de Janeiro, Brazil, marked in Simon's handwriting *"Dip. striatipes";* however the usual "E. S." of described species is missing.

Soares and Camargo's specimen has a carapace like that of the Venezuelan male illustrated (Figs. 59, 60). The only palpus is mounted on a slide, transparent and flattened. However, the embolus is the same shape as that of other specimens.

Distribution. Panama to Paraguay.

Additional Records. Panama Canal Zone: Forest Reserve, ♀ (A. M. Chickering). *Venezuela.* "Caracas; San Estebán," ♀ (E. Simon, MNHN). *Brazil:* Rio de Janeiro, ♀ (Germain, MNHN). *Paraguay:* Mato Grosso, ♀ (MNHN).

Dipoena bellingeri sp. n.

Figures 66, 67

Type. Female holotype from west side John Crow Mountains, St. Thomas Parish, 900 m alt., Jamaica, British West Indies, 22 June 1956 (P. F. Bellinger), in the Museum of Comparative

Zoology. The species is named after the collector.

Description. Carapace, sternum dark brown. Coxae and proximal half of third and fourth femora yellow-white, other leg segments dark brown with indistinct lighter rings. Abdomen black with a short white stripe above spinnerets. Eyes subequal in size. Anterior median eyes less than their diameter apart, their radius from laterals. Posterior eyes their radius apart. Total length 1.6 mm. Carapace 0.66 mm long, 0.61 mm wide. First patella and tibia 0.55 mm; second 0.52 mm; third 0.52 mm. Fourth femur 0.62 mm; patella and tibia 0.65 mm; metatarsus 0.36 mm; tarsus 0.29 mm.

Diagnosis. The epigynum (Fig. 67) of *D. bellingeri* is quite indistinct: it is heavily pigmented, and examinations of the internal genitalia thus is difficult. In no other species known from the West Indies does the epigynum have a depression posterior to a lip.

Natural History. The specimen was collected from moss and wet leaf litter.

Dipoena proterva Chickering

Figures 70-73

Dipoena proterva Chickering, 1943, Trans. Amer. Micros. Soc., 62: 371, figs. 60-63, ♀, ♂. Male holotype from Barro Colorado Isl., Panama Canal Zone, in the Museum of Comparative Zoology, examined.

This species is yellow-white; clypeus with a black line. Abdomen white with a dark spot on each side of spinnerets and dark on venter anterior to pedicel.

Dipoena seclusa Chickering

Figures 74-77

Dipoena seclusa Chickering, 1948, Trans. Amer. Micros. Soc., 67: 335, figs. 4-7, ♀, ♂. Male holotype from Canal Zone Biological Area, Panama Canal Zone, in the Museum of Comparative Zoology, examined.

Carapace dark brown, sternum gray, legs brown; abdomen black with a white spot above spinnerets; venter light.

Dipoena parki Chickering

Figures 78-80

Dipoena parki Chickering, 1943, Trans. Amer. Micros. Soc., 62: 366, figs. 52, 53, ♀. Female holotype from Barro Colorado Isl., Panama Canal Zone, in the Museum of Comparative Zoology, examined.

Carapace dark brown, cephalic area light brown, legs yellowish. Abdomen gray with black and white marks (Fig. 78); venter black anterior to pedicel, otherwise gray; black on each side of spinnerets.

Dipoena eatoni Chickering

Figures 81-83

Dipoena eatoni Chickering, 1943, Trans. Amer. Micros. Soc., 62: 350, figs. 30, 31, ♀. Female holotype from El Valle, Panama, in the Museum of Comparative Zoology, examined. — Levi, 1953, Amer. Mus. Novitates, no. 1639: 3.

This species is almost black, but has some small light spots on dorsum of the abdomen. The course of the ducts and posterior seminal receptacles is uncertain (Fig. 82).

Distribution. Chiapas; Panama.

Dipoena anas sp. n.

Figures 68, 69

Type. Male holotype from Boquete, Panama, 4-11 August 1954 (A. M. Chickering), in the Museum of Comparative Zoology. The specific name is an arbitrary combination of letters.

Description. Carapace yellow, eye region dusky. Sternum slightly dusky. Legs yellow. Abdomen dusky gray but spinnerets yellow. Carapace quite high with a semicircular depression (Fig. 68). Anterior median eyes much larger than others, their diameter apart and almost touching laterals. Posterior median eyes one-third their diameter apart, one and one-half diameters from laterals. Total length 1.7 mm. Carapace 0.78 mm long, 0.69 mm wide, 0.53 mm high. First patella and tibia 0.80 mm; second 0.63 mm; third 0.55 mm. Fourth femur 0.75 mm; patella and tibia 0.80 mm; metatarsus 0.47 mm; tarsus 0.38 mm.

Diagnosis. The winding of the duct in the embolus base (Fig. 69) separates this species from *D. atlantica* and others.

Dipoena morosa Bryant

Figures 84-86

Dipoena morosa Bryant, 1948, Bull. Mus. Comp. Zool., 100: 376, figs. 50, 52, 53, ♂. Male holotype from San José de la Matas, Dominican Republic, in the Museum of Comparative Zoology.

Note. Carapace dark brown. Legs pale with darker rings on distal ends of femora and tibiae. Abdomen brown; covered with

white spots. Both palpi of the type specimen seem lost. The drawing (Fig. 85) was made from a sketch made of the type in 1955. Figures 84, 86 are from a Brazilian specimen.

Record. Brazil. Mato Grosso: Corumbá, 8 Jan. 1959 (A. M. Nadler, AMNH).

Dipoena taeniatipes Keyserling

Figures 87-89

Dipoena taeniatipes Keyserling, 1891, Die Spinnen Amerikas, Brasilianische Spinnen, 3: 224, pl. 9, fig. 165, ♀. Female holotype from Rio Grande do Sul, Brazil, in the British Museum, examined.

The abdomen of this species is heart-shaped (Fig. 87), sometimes all shiny black, sometimes with lighter areas.

Record. Brazil. Santa Catarina: Nova Teutonia, lat 27°11′ S, long 52°23′ W (F. Plaumann, SMF).

Dipoena olivenca sp. n.

Figures 90-92

Type. Female holotype from São Paulo de Olivença, Amazonas, Brazil (M. de Mathan), in the Muséum National d'Histoire Naturelle, Paris (no. 9164). The specific name is a noun in apposition after the type locality.

Description. Carapace, sternum, legs, yellow-brown. Dorsum of abdomen dark gray with some areas lacking pigment (Fig. 90); venter yellowish without pigment. Anterior median eyes larger than others, two-thirds diameter apart, almost touching laterals. Posterior median eyes two-thirds diameter apart, one diameter from laterals. Total length 2.9 mm. Carapace 1.04 mm long, 0.83 mm wide. First patella and tibia, 1.06 mm; second, 0.97 mm; third, 0.83 mm. Fourth femur 1.10 mm; patella and tibia 1.24 mm; metatarsus 0.82 mm; tarsus 0.33 mm.

Diagnosis. The epigynum, which has a heavily sclerotized plate, is similar to that of *D. pumicata;* the internal genitalia, however, separate the two species (Figs. 91, 92). The very heavily sclerotized ducts are much longer and surround the posterior seminal receptacles on their anterior face.

Records. Two ♀ paratypes collected with type.

Dipoena opana sp. n.

Figures 93-95

Type. Female holotype from Nova Teutonia, lat 27°11′ S, long 52°23′W, Santa Catarina, Brazil, 1930-1940 (F. Plaumann), in

the Senckenberg Museum (no. R II/8128/1). The specific name is an arbitrary combination of letters.

Description. Carapace yellow-brown. Sternum yellowish. Legs brown. Abdomen shiny, brownish with venter lighter. Eyes subequal in size. Anterior median eyes two-thirds their diameter apart, almost touching laterals. Posterior eyes their radius apart. Chelicerae without teeth, with usual long fang. Total length 1.8 mm. Carapace 0.61 mm long, 0.59 mm wide. First patella and tibia, 0.59 mm; second, 0.55 mm; third, 0.62 mm. Fourth femur, 0.65 mm; patella and tibia, 0.87 mm; metatarsus, 0.39 mm; tarsus, 0.36 mm.

Diagnosis. This species differs from most *Dipoena* in having the third legs relatively long. The posterior seminal receptacles are elongated and the duct to the outside is extremely short (Figs. 94, 95), unlike other *Dipoena.*

Records. ♀ paratype collected at type locality.

Dipoena zeteki Chickering

Figures 96-98

Dipoena zeteki Chickering, 1943, Trans. Amer. Micros. Soc., 62: 376, figs. 67-68, ♀. Female holotype from Ft. Davis, Panama Canal Zone, in the Museum of Comparative Zoology, examined.

Carapace light brown. Dorsum of abdomen gray with white marks (Fig. 96), a large white stripe above spinnerets; venter light.

Dipoena plaumanni sp. n.

Figures 99-104

Type. Male holotype from Nova Teutonia, lat 27°11′ S, long 52°23′ W, Santa Catarina, Brazil, July 1955 (F. Plaumann) in the Institut Royal des Sciences Naturelle de Belgique, Brussels. The species is named after the collector.

Description. Carapace, sternum, legs, yellow. Abdomen yellow with a grayish cast, lighter above spinnerets. Carapace of male only slightly elevated with grooves (Figs. 99, 100). Diameter of anterior median eyes almost twice that of other eyes. Anterior median eyes less than one-quarter diameter apart, less than one-quarter diameter from laterals. Posterior median eyes about two-thirds diameter apart and their radius from laterals in females; their radius apart and two-thirds diameter from laterals in male. Total length of female 2.2 mm. Carapace 0.72 mm long,

0.66 mm wide. First patella and tibia 0.72 mm; second 0.68 mm; third 0.64 mm. Fourth femur 0.80 mm; patella and tibia 0.84 mm; metatarsus 0.56 mm; tarsus 0.40 mm. Total length of male 1.7 mm. Carapace 0.76 mm long, 0.63 mm wide. First patella and tibia 0.72 mm; second 0.64 mm; third 0.64 mm. Fourth femur 0.80 mm; patella and tibia 0.84 mm; metatarsus 0.48 mm; tarsus 0.40 mm.

It is not certain that the male and female belong together.

Diagnosis. The male palpus has a distinctive sclerite (Figs. 103, 104) resembling that of *D. kuyuwini.* However, *D. kuyuwini* has a higher carapace and dark spotted abdomen. The ducts connecting the anterior and posterior pair of seminal receptacles are longer than in most species, the connecting ducts shorter and the openings indistinct, behind a small sclerotized lip (Fig. 102).

Record. ♀ from type locality Feb. 1956.

Dipoena kuyuwini sp. n.

Figures 105-108

Type. Male holotype from Kuyuwini Landing, Kuyuwini River, British Guiana, 1937 (W. G. Hassler), in the American Museum of Natural History. The specific name is a noun in apposition after the type locality.

Description. Male. Carapace yellow-brown. Sternum dusky. Legs dusky, venter with faint indication of dusky bands. Dorsum of abdomen spotted black and white (Fig. 105), venter light. Carapace of male very high, cylindrical, with grooves. Anterior median eyes much larger than others, their radius apart, almost touching laterals. Posterior median eyes their radius apart, their diameter from laterals. Total length of male 1.9 mm. Carapace 0.98 mm long, 0.78 mm wide, 0.92 mm high. First patella and tibia 1.04 mm; second 0.85 mm; third 0.78 mm. Fourth femur 1.00 mm; patella and tibia 1.10 mm; metatarsus 0.80 mm; tarsus 0.41 mm.

The epigynum (Fig. 107) illustrated belongs to a female probably of this species. This is not certain because the male is accompanied by fragments of two different females with similar color pattern.

Diagnosis. A posterior-pointing sclerite covering the tegulum (Fig. 108) separates this species from most *Dipoena,* and the cymbium, which has teeth on the distal tip, separates this species from *D. plaumanni.*

Records. Venezuela. Carabobo: San Estebán, 1888, ♂ (E. Simon, MNHN). *British Guiana:* Kuyuwini River, Kuyuwini Landing, ♂ paratype, 2 ♀ fragments (W. G. Hassler, AMNH).

Dipoena beni sp. n.
Figures 111-113

Type. Female holotype from Rurrenabaque, Beni, Bolivia, Oct.-Nov. 1956 (L. Peña), in the Institut Royal des Sciences Naturelles de Belgique, Brussels. The specific name is a noun in apposition after the type locality.

Description. Carapace red-brown with dusky border. Sternum yellow-brown, legs red-brown. Abdomen dark gray to black with indistinct lighter spots; venter colorless in center and around pedicel; sides of posterior nearly black. Anterior median eyes slightly larger than others, one-third diameter apart, almost touching laterals. Posterior median eyes one-third diameter apart, their radius from laterals. Abdomen of somewhat irregular shape (Fig. 111). Total length of female 2.5 mm. Carapace 0.91 mm long, 0.98 mm wide. First patella and tibia 1.36 mm; second 1.10 mm; third 0.98 mm. Fourth femur 1.36 mm; patella and tibia 1.50 mm; metatarsus 1.17 mm; tarsus 0.60 mm.

Diagnosis. Dipoena beni is similar to *D. pumicata* but differs in having the posterior margin of the epigynum more heavily sclerotized (Fig. 113), and the posterior seminal receptacles are more anterior (Fig. 112) than those of *D. pumicata.* The internal ducts of *D. beni* are difficult to see.

Dipoena peruensis sp. n.
Figures 131-132

Type. Female holotype from Upper Pachitea River, Pasco, Peru, 21 July 1920, in the American Museum of Natural History. The specific name is an adjective after the the country of the type locality.

Description. Carapace very dark brown, nearly black. Sternum black. Legs yellow, with a black line anterior on first and second legs, posterior on third and fourth. Abdomen subtriangular, black, venter somewhat lighter; area of the epigynum reddish brown. Carapace projecting above the clypeus, highest in thoracic region. Anterior median eyes much larger than others. Anterior median eyes one diameter apart, almost touching laterals. Posterior median eyes two diameters apart, one and

one-half diameters from laterals. Total length 2.00 mm. Carapace 0.96 mm long, 0.65 mm wide, 0.36 mm high. First patella and tibia 0.78 mm; second 0.65 mm; third 0.58 mm. Fourth femur 0.78 mm; patella and tibia 0.85 mm; metatarsus 0.50 mm.

Diagnosis. The epigynum (Fig. 132), which has two sclerotized anterior wings, separates this species from *D. anahua* and others.

Records. "Parag. M. Grosso," ♀ (E. Gounelle, MNHN).

Dipoena perimenta sp. n.

Figures 133-137

Type. Male holotype from Experimental Gardens, Panama Canal Zone, 12-19 Aug. 1945 (A. M. Chickering), in the Museum of Comparative Zoology. The specific name is an arbitrary combination of letters.

Description. Carapace, sternum, legs and abdomen yellowish; eye region black. A dark median longitudinal line on abdomen dorsum. Carapace of male high (Figs. 133-134), that of female highest behind eyes. Anterior median eyes almost twice the diameter of others. Anterior median eyes two-thirds to one diameter apart, almost touching laterals. Posterior eyes about one diameter or slightly more apart. Abdomen of female covered with sclerotized setae, that of male two-thirds covered by a dorsum scutum. Total length of female 1.0 mm. Carapace 0.50 mm long, 0.52 mm wide. First patella and tibia 0.49 mm; second 0.47 mm; third 0.45 mm. Fourth femur 0.61 mm; patella and tibia 0.71 mm; metatarsus 0.32 mm; tarsus 0.26 mm. Total length of male 1.1 mm. Carapace 0.60 mm long, 0.52 mm wide, 0.44 mm high. First patella and tibia 0.45 mm; second 0.44 mm; third 0.36 mm. Fourth femur 0.52 mm; patella and tibia 0.65 mm; metatarsus 0.27 mm; tarsus 0.26 mm.

Diagnosis. The wider ducts in the female genitalia (Fig. 135), and the lack of a sclerotized anterior scale overhanging the opening (Fig. 136) separate the female from *D. alta.* The male is distinct from *D. alta* in having only three radial grooves on the carapace (Fig. 134), and in the different course of ducts in the palpus (Fig. 137).

Records. Panama Canal Zone: Experimental Gardens, ♀, ♂ paratypes (A. M. Chickering); Forest Reserve; Madden Dam (A. M. Chickering).

Dipoena alta Keyserling
Figures 138-139; Map 2

Dipoena alta Keyserling, 1886, Die Spinnen Amerikas, Theridiidae, 2(2): 45, pl. 12, fig. 159, ♂. Male type from Montaña de Nancho, [?Cajamarca], Peru, in the Polish Academy of Sciences, Warsaw, examined.

Euryopis lutea Keyserling, 1891, *op. cit.*, Brasilianische Spinnen, 3: 227, pl. 9, fig. 168, ♀. Female type from Serra Vermella, [Est. Rio de Janeiro], Brazil, in the British Museum, examined. NEW SYNONYMY.

Dipoena lineatipes Bryant, 1933, Bull. Mus. Comp. Zool., 74: 174, fig. 7, ♀. Female holotype from Royal Palm Park, Florida, in the Museum of Comparative Zoology, examined. — Levi, 1953, Amer. Mus. Novitates, no. 1647: 12, figs. 11-15, 120-121, ♀, ♂. NEW SYNONYMY.

Dipoena pallida Chickering, 1943, Trans. Amer. Micros. Soc., 62: 364, figs. 50, 51, ♀. Female holotype from Barro Colorado Isl., Panama, in the Museum of Comparative Zoology, examined. Preoccupied by *Dipoena pallida* (Emerton). NEW SYNONYMY.

Dipoena furtiva Chickering *in* Roewer, 1951, Abhandl. naturwiss. Ver. Bremen, 32: 455. New name for *D. pallida* Chickering, preoccupied. — Levi, 1953, Amer. Mus. Novitates, no. 1639: 3, fig. 18, ♀. NEW SYNONYMY.

Figures 138, 139 were made from the type of *Euryopis lutea*.

Natural History. This species probably occurs on shrubs or trees, judging by the specimens collected by Mr. Nadler who mostly collects by beating vegetation.

Distribution. Florida, Alabama, Texas, Puebla (Mexico), Panama, Jamaica, Peru, Brazil (Map 2).

Additional Records. Mexico. Veracruz [no locality]. *Panama Canal Zone:* Forest Reserve; Barro Colorado Isl.; Summit; Experimental Gardens (all A. M. Chickering). *Panama:* El Volcán (A. M. Chickering). *British West Indies: Jamaica:* Hardwar Gap, Blue Mts. (A. M. Chickering); Morces Gap, St. Andrew Par. (M. W. Sanderson). *Trinidad:* Simla (A. M. Nadler, AMNH), *Venezuela, Carabobo:* San Estebán (E. Simon, MNHN). *Aragua:* Tovar (E. Simon, MNHN). *Ecuador: El Oro:* Río Jubanes, Pasaje (R. Walls). *Peru. Huánuco:* Divisoria, 1700 m (F. Woytkowski). *Brazil. Espírito Santo:* Santa Teresa (A. M. Nadler, AMNH). *Minas Gerais:* Caraça (E. Gounelle, MNHN). *Est. Rio de Janeiro:* Teresópolis (H. Sick AMNH); Rio de Janeiro (A. M. Nadler AMNH). *São Paulo:* Forest Reservation, São Paulo (A. M. Nadler, AMNH). *Mato Grosso:* (MNHN); Campo Grande (A. M. Nadler, AMNH).

Dipoena waspucensis sp. n.
Figures 140-142

Type. Female holotype from Musawas, Waspuc River, Nicaragua, 10-31 Oct. 1955 (B. Malkin), in the American Museum of Natural History. The specific name is an adjective after the type locality.

Description. Carapace, sternum, legs dusky light brown. Legs lightest at proximal end, metatarsi darkest. Dorsum of abdomen mottled gray (Fig. 140), venter very light gray. Anterior median eyes slightly larger than others, one-third their diameter apart almost touching laterals. Posterior median eyes their radius apart, two-thirds diameter from laterals. Total length 2.8 mm. Carapace 0.84 mm long, 0.93 mm wide. First patella and tibia 1.20 mm; second 1.06 mm; third 0.96 mm. Fourth femur 1.20 mm; patella and tibia 1.20 mm; metatarsus 0.98 mm; tarsus 0.45 mm.

Diagnosis. The coloration and the epigynum opening with anterior and lateral lips (Fig. 142) separate *D. waspucensis* from *D. alta* and *D. perimenta.*

Dipoena longiventris (Simon), new combination
Figures 114-115

Euryopis longiventris Simon, 1905, Boll. Musei Zool. Anat. Comp. Univ. Torino, 20(511): 6. Female holotype from Chabut, Puerto Piramides [Puerto Pirámide, Chubut], Argentina, in the Muséum National d'Histoire Naturelle, Paris, examined.

The carapace is golden yellow and the abdomen covered with spots and transverse bands.

Dipoena venusta Chickering
Figures 116-118

Dipoena venusta Chickering, 1948, Trans. Amer. Micros. Soc., 67: 339, figs. 11-12, ♀. Female holotype from Ft. Sherman, Panama Canal Zone, in the Museum of Comparative Zoology, examined.

This species is whitish except for a narrow line on the clypeus, a black mark on the venter of the abdomen anterior to the pedicel and a gray patch between the brown epigynum and spinnerets.

Dipoena esra sp. n.

Figures 119-121

Type. Female holotype from Tingo María, Huánuco, Peru, 8 Oct. 1946 (J. C. Pallister), in the American Museum of Natural History. The specific name is an arbitrary combination of letters.

Description. Carapace yellow-white, slightly dusky on sides. Sternum, legs, yellow-white. Abdomen yellow-white, venter black anterior to pedicel, anterior margin of dorsum black, and a square black area between epigynum and spinnerets. The dorsum has some indistinct gray spots (Fig. 119). Eyes subequal in size. Anterior medians three-quarters diameter apart, almost touching laterals. Posterior medians their radius apart, one diameter from laterals. Total length 1.6 mm. Carapace 0.68 mm long, 0.67 mm wide, 0.45 mm high. First patella and tibia 0.78 mm; second 0.75 mm; third 0.60 mm. Fourth femur 0.78 mm; patella and tibia 0.85 mm; metatarsus 0.39 mm; tarsus 0.27 mm.

Diagnosis. The very heavy connecting ducts (Fig. 120) separate this species from other known species of *Dipoena*.

Dipoena mertoni sp. n.

Figures 122-124

Type. Female holotype from Boquete, Panama, 1-8 Aug. 1950 (A. M. Chickering), in the Museum of Comparative Zoology. The species is named after Dr. A. M. Chickering.

Description. Carapace, sternum, legs yellow-white. Abdomen yellow-white, a pair of black spots above spinnerets on dorsum and anterior of dorsum gray with a light patch in middle (Fig. 122). Eyes subequal in size. Anterior median eyes two-thirds diameter apart, one-quarter from laterals. Posterior median eyes one-third diameter apart, one diameter from laterals. Total length 1.6 mm. Carapace 0.83 mm long, 0.80 mm wide. First patella and tibia 1.0 mm; second 0.85 mm; third 0.80 mm. Fourth femur 1.04 mm; patella and tibia 1.07 mm; metatarsus 0.71 mm; tarsus 0.39 mm.

Diagnosis. The subtriangular shape of the abdomen (Fig. 122) and shorter connecting ducts (Fig. 123) separate this species from *D. bernardino* and *D. daltoni* which have a similar epigynum.

Dipoena woytkowskii sp. n.
Figures 147-149

Type. Female holotype from Utcuyacu, Junín, Peru, 1600-2200 m alt. March 1948 (F. Woytkowski), in the American Museum of Natural History. The species is named after F. Woytkowski, the collector.

Description. Carapace yellow-brown, dusky on sides. Sternum dusky gray. Legs yellow-brown with gray rings, proximal half of femora and coxae yellow. Dorsum of abdomen with black, gray and white pattern (Figs. 147), a white spot above spinnerets; venter gray. Eyes subequal in size. Anterior median eyes their radius apart, almost touching laterals. Posterior median eyes one-quarter diameter apart, less than their diameter from laterals. Total length 2.5 mm. Carapace 0.94 mm long, 0.91 mm wide. First patella and tibia 0.95 mm; second 0.91 mm; third 0.78 mm. Fourth femur 1.06 mm; patella and tibia 1.14 mm; metatarsus 0.67 mm; tarsus 0.42 mm.

Diagnosis. This species can be separated from *D. obscura* and other *Dipoena* having a similar epigynum (Fig. 149) by the shape and pattern of the abdomen (Fig. 147).

Records. Venezuela. Carabobo: San Estebán, 1888, ♀ doubtful determination (E. Simon, MNHN). *Peru. Huánuco:* Tingo María, 10 Jan. 1947, ♀ paratype (J. C. Pallister, AMNH). [?] "San Martín," 15, 16 Dec. 1946, ♀ (J. C. Pallister, AMNH).

Dipoena conica Chickering
Figures 143-146

Dipoena conica Chickering, 1943, Trans. Amer. Micros. Soc., 62: 341, figs. 18, 19, ♀. Female holotype from Barro Colorado Isl., Panama Canal Zone, in the Museum of Comparative Zoology, examined.

Dipoena cylindrica Soares and Camargo, 1955, Arq. Mus. Nacional, Rio de Janeiro, 42: 580, figs. 9, 12, 13, ♂. Male holotype from Pirenópolis, Goías, Brazil, in the Departamento de Zoologia da Secretaria da Agricultura do Estado de São Paulo. Paratype examined. NEW SYNONYMY.

Note. The paratype of *D. cylindrica* examined has lost its abdomen. The palpus resembles *D. conica.* The original description mentions abdomen coloration but not shape. It may have been damaged. Since no other specimens of *D. conica* are known from South America and since the shape of the abdomen is a diagnostic feature, there is the possibility that *D. cyclindrica*

might be *D. atlantica* Chickering. Soares and Camargo's illustration (reproduced by Fig. 56) was probably made from a cleared palpus.

The conical abdomen (Fig. 143) distinguishes this species from the related *D. atlantica* and all other *Dipoena*.

Distribution. Panama and south central Brazil.

Records. Panama Canal Zone: Barro Colorado Island, ♀, ♂ (A. M. Chickering).

Dipoena atlantica Chickering
Figures 150-154

Dipoena atlantica Chickering, 1943, Trans. Amer. Micros. Soc., 62: 330, figs. 1-4, ♀, ♂. Male holotype from Barro Colorado Island, Panama Canal Zone, in the Museum of Comparative Zoology, examined.

The rounded abdomen distinguishes this species from *D. conica*, the pattern on the abdomen (Fig. 150) from *D. insulana*, the long transparent anterior lip of the epigynum (Figs. 152, 153) from *D. pusilla*.

Additional Records. Panama Canal Zone: Summit (A. M. Chickering). *Venezuela. Carabobo:* San Estebán (E. Simon, MNHN). *Peru. Huánuco:* Divisoria, 1700 m (F. Woytkowski, AMNH). *Brazil. Minas Gerais:* Caraça (E. Gounelle, MNHN). *Rio de Janeiro:* Paineiras, ♀ doubtful det. (A. M. Nadler, AMNH); Niterói, ♂ (E. Gounelle, MNHN). *Mato Grosso:* ♀ (MNHN). *Paraguay:* ♀ (MNHN).

Dipoena standleyi sp. n.
Figures 155-159

Type. Female holotype from Balboa, Panama Canal Zone, Aug. 1956 (A. M. Chickering), in the Museum of Comparative Zoology. The species is named after P. C. Standley, botanist.

Description. Carapace, sternum, legs, yellowish without pigment except some pigments in anterior median eyes. Abdomen yellowish, some dusky to black marks on dorsum (Figs. 156, 157) and some black spots anterior on venter (Fig. 155); back of paratype with a black band on anterior half of dorsum and without ventral black spots. Anterior median eyes slightly larger than others, two-thirds diameter apart, almost touching laterals. Posterior median eyes their radius apart, two-thirds diameter from laterals. Total length 2.4 mm. Carapace 0.94 mm long, 0.91 mm wide. First patella and tibia 0.94 mm; second

0.88 mm; third 0.78 mm. Fourth femur 0.98 mm; patella and tibia 1.04 mm; metatarsus 0.66 mm; tarsus 0.40 mm.

Diagnosis. The shape and color of the abdomen distinguishes this species from *D. obscura, D. atlantica, D. conica* and *D. donaldi. Dipoena standleyi* also differs from these species, all of which have similar epigyna, in that the ducts connecting the anterior and posterior seminal receptacles are heavily sclerotized and can be seen through the epigynum (Figs. 158, 159).

Records. Panama Canal Zone: Barro Colorado Isl., Standley Trail, 21 Aug. 1954, ♀ paratype (A. M. Chickering).

Dipoena obscura Keyserling
Figures 169-170

Dipoena obscura Keyserling, 1891, Die Spinnen Amerikas, Brasilianische Spinnen, 3: 226, pl. 9, fig. 167, ♀. Female holotype from Serra Vermelha, [Est. Rio de Janeiro], Brazil, in the British Museum, examined.

Coloration blackish brown; only on the posterior part of the carapace are two light areas, and the distal ends of the legs are yellow. The abdomen is oval in outline, rounded behind and in front, and is shiny (Keyserling, 1891). It differs in coloration from *D. standleyi.*

Dipoena anahuas sp. n.
Figures 171-173

Type. Female holotype from Cañon de las Anahuas, Linares, Nuevo Léon, Mexico, 18 July 1942 (F. Bonet, D. Palaez), in the American Museum of Natural History. The specific name is a noun in apposition after the type locality.

Description. Carapace yellow, eye region dusky, margin black, a series of three dusky spots on each side, and a dusky spot in middle. Sternum, legs, yellow. Abdomen dorsum having light spots on gray (Fig. 171), venter light with a gray ring around spinnerets. Anterior median eyes slightly larger than others, two-thirds their diameter apart, almost touching laterals. Posterior median eyes their radius apart. Total length 1.5 mm. Carapace 0.62 mm long, 0.59 mm wide. First patella and tibia 0.57 mm; second 0.55 mm; third 0.54 mm. Fourth femur 0.62 mm; patella and tibia 0.72 mm; metatarsus 0.41 mm; tarsus 0.36 mm.

Diagnosis. The coloration and the central sclerotized plate of the epigynum (Fig. 173) readily separate this species from *D. obscura* and *D. standleyi.*

Dipoena pusilla (Keyserling), new combination

Figures 160-162

Euryopis pusilla Keyserling, 1886, Die Spinnen Amerikas, Theridiidae, 2(2): 263, pl. 21, fig. 311, ♀. Female holotype from Blumenau, [Santa Catarina], Brazil, in the British Museum, examined.

This species is much darker than *D. atlantica.* The abdomen has only a few light spots on the dorsum and a white spot above the spinnerets (Fig. 160). The anterior lip above the opening of the epigynum is shorter (Fig. 162) than that of *D. atlantica.*

Record. Brazil. Rio de Janeiro: Niterói, ♀ (E. Gounelle, MNHN).

Dipoena donaldi Chickering

Figures 163-168

Dipoena donaldi Chickering, 1943, Trans. Amer. Micros. Soc., 62: 347, figs. 24-26, ♂. Male holotype from Fort Davis, Panama Canal Zone, in the Museum of Comparative Zoology, examined.

Description. Female carapace yellow-brown. Sternum dusky. Legs yellowish above, dusky to black on venter. Subtriangular abdomen black, one specimen whitish with a gray band across dorsum and a gray patch anterior to it. Total length of female 2.2 mm. Carapace 0.80 mm long, 0.75 mm wide. First femur 1.00 mm; patella and tibia 1.09 mm; metatarsus 0.73 mm; tarsus 0.31 mm. Second patella and tibia 0.95 mm; third 0.83 mm; fourth 1.00 mm.

Variation. Venezuelan specimens are much smaller than the type from Panama. The carapace of the male is not quite as tall and there are some small differences in the palpi (Figs. 167, 168). Figure 167 was prepared from the type.

Records. Venezuela. Aragua: Rancho Grande, 24 June-1 July 1945, ♂ (W. Beebe, AMNH); Dec. 1954, ♀, ♂ (A. M. Nadler, AMNH).

Dipoena insulana Chickering

Figures 174-177

Dipoena insulana Chickering, 1943, Trans. Amer. Micros. Soc., 62: 355, figs. 36-39, ♀, ♂. Male holotype from Barro Colorado Island, Panama Canal

Zone, in the Museum of Comparative Zoology, examined. — Levi, 1953, Amer. Mus. Novitates, no. 1639: 8.

Carapace, sternum gray; legs yellow with black spots on venter; abdomen blackish with light spots on dorsum (Fig. 174), and also a white line above the spinnerets; venter light.

Distribution. Western Mexico to Panama.

Additional Record. Nicaragua: Musawas, Waspuc River (B. Malkin, AMNH).

Dipoena puertoricensis sp. n.

Figures 178-180

Type. Female holotype from El Yunque, Puerto Rico, 27, 28 Feb. 1955 (A. M. Nadler), in the American Museum of Natural History. The specific name is an adjective after the island of the type locality.

Description. Carapace dusky gray with a black line across middle. Sternum gray. Legs yellow with narrow black rings that are more distinct on venter. Dorsum of abdomen with a gray pattern (Fig. 178); venter gray. Eyes subequal in size, appearing very large. Anterior median eyes one-quarter diameter apart, almost touching laterals. Posterior eyes one-third diameter apart. Total length 1.7 mm. Carapace 0.66 mm long, 0.58 mm wide. First patella and tibia 0.62 mm; second 0.58 mm; third 0.52 mm. Fourth femur 0.67 mm; patella and tibia 0.67 mm; metatarsus 0.41 mm; tarsus 0.36 mm.

Diagnosis. The coloration (Fig. 178) and proportions separate this species from *D. rubellum*. The epigynum (Fig. 180) is similar.

Dipoena niteroi sp. n.

Figures 181, 182

Type. Male holotype from Niterói, Est. Rio de Janeiro, Brazil, in the Muséum National d'Histoire Naturelle, Paris (no. 9143). The specific name is a noun in apposition after the type locality.

Description. Carapace yellowish, black between eyes with a broad black band between eyes and cheliceral margin of clypeus. Chelicerae with some black. Sternum yellow-white. Legs yellow-white with black spots below; cymbium of palpus black. Abdomen with white pigment on dorsum, some black anterior (Fig. 181) and gray pigment on venter. Carapace of male much higher than long, with grooves as in many other *Dipoena* species.

Anterior median eyes slightly larger than others, their radius apart, almost touching laterals. Posterior median eyes one diameter apart, one and one-half diameters from laterals. Abdomen triangular (Fig. 181). Total length 1.5 mm. Carapace 0.65 mm long, 0.62 mm wide, 0.68 mm high. First patella and tibia, 0.52 mm; second, 0.52 mm; third, 0.43 mm. Fourth femur, 0.55 mm; patella and tibia, 0.59 mm; metatarsus, 0.32 mm; tarsus, 0.26 mm.

Diagnosis. This species can be separated from *D. militaris* by the shape of the embolus and by the subtriangular abdomen (Fig. 181); it differs from *D. santacatarinae* by having embolus and conductor of different shape (Fig. 182).

Dipoena variabilis (Keyserling), new combination

Figures 185, 186

Euryopis variabilis Keyserling, 1886, Die Spinnen Amerikas, Theridiidae, 2(2): 262, pl. 21, fig. 310, ♀. Female holotype from Blumenau, [Santa Catarina], Brazil, in the British Museum, examined.

This species is not the same as *Euryopis variabilis,* — Levi, 1954, Amer. Mus. Novitates, no. 1666: 23, figs. 25, 26, 35, from Florida.

Carapace dark brown. Chelicerae, sternum, legs, yellow. Abdomen dorsum dark, nearly black, with light patches varying in position in different specimens, a light stripe just above spinnerets. Venter of abdomen yellow.

Records. Brazil. Minas Gerais: Caraça (E. Gounelle, MNHN). *Rio de Janeiro:* Niterói (E. Gounelle, MNHN).

Dipoena superba Chickering

Figures 183-184

Dipoena superba Chickering, 1948, Trans. Amer. Micros. Soc., 67: 337, figs. 8-10, ♂. Male holotype from Ft. Sherman, Panama Canal Zone, in the Museum of Comparative Zoology, examined. — Levi, 1953, Amer. Mus. Novitates, no. 1639: 10.

This species is yellowish white with black stripes on dorsum of abdomen, and white pigment spots (Fig. 183).

Distribution. Chiapas, Mexico to Panama.

Dipoena rubellum (Keyserling), new combination

Figures 187-190

Theridion rubellum Keyserling, 1884, Die Spinnen Amerikas, Theridiidae, 2(1): 63, pl. 3, fig. 37, ♀. Abdomen of female holotype from Amable

María, [Junín], Peru, in the Polish Academy of Sciences, Warsaw, examined.

Dipoena petrunkevitchi Chickering, 1943, Trans. Amer. Micros. Soc., 62: 368, figs. 54-59, ♀, ♂. Male holotype from Barro Colorado Isl., Panama Canal Zone, in the Museum of Comparative Zoology, examined. Preoccupied by *D. petrunkevitchi* Roewer, 1942. NEW SYNONYMY.

Dipoena roeweri Chickering *in* Roewer, 1951, Abhandl. naturwiss. Ver. Bremen, 32: 455. New name for *D. petrunkevitchi* Chickering preoccupied. NEW SYNONYMY.

The abdomen and prosoma of the type of *T. rubellum* belong to different female specimens. The prosoma is that of an unknown *Theridion*. Figures 188, 189 were prepared from the type.

Prosoma, legs, yellowish. Dorsum of abdomen with white spots on background of purplish to red anterior, gray to black posterior; venter light.

Distribution. Panama, Peru, southern Brazil.

Records. Brazil. Amazonas: Fonte Boa, ♀ (Mathews, MNHN). *Santa Catarina:* Nova Teutonia, lat 27°11′ S, long 52°23′ W (F. Plaumann, SMF).

Dipoena bryantae Chickering

Figures 191-193

Dipoena bryantae Chickering, 1943, Trans. Amer. Micros. Soc., 62: 339, figs. 14-17, ♀, ♂. Male holotype from Barro Colorado Isl., Panama Canal Zone, in the museum of Comparative Zoology, examined.

Carapace, sternum, legs, dark gray-brown, proximal portions of femora and distal segments lighter; subtriangular abdomen black.

Natural History. This species is probably found on vegetation.

Additional Records. Panama Canal Zone: Summit (A. M. Chickering). *Lesser Antilles. Trinidad:* Piarco (A. M. Nadler, AMNH); Simla near Arima (A. M. Nadler, AMNH).

Dipoena santacatarinae sp. n.

Figures 194-198

Type. Male holotype from Nova Teutonia, lat 27°11′ S, long 52°23′ W, Santa Catarina, Brazil (F. Plaumann), in the Senckenberg Museum (no. R II/13472/1). The species is named after Santa Catarina.

Description. Carapace white, black below anterior median eyes and a black spot on clypeus. Chelicerae with some black pigment anterior. Sternum yellow-white. Legs white with indistinct

brown bands. Abdomen whitish with small white pigment spots on dorsum and anterior border blackish. Carapace of male very high with grooves (Fig. 195). Anterior median eyes of male slightly larger than others, one diameter apart, touching laterals. Posterior median eyes two-thirds diameter apart, one diameter from laterals. Anterior median eyes of female their radius apart, touching laterals. Posterior median eyes their radius apart, one diameter from laterals. Abdomen of female wider than long with some gray around spinnerets. Total length of female 1.7 mm. Carapace 0.36 mm long, 0.33 mm wide. First patella and tibia, 0.34 mm; second, 0.34 mm; third 0.31 mm. Fourth femur, 0.89 mm; patella and tibia, 0.40 mm; metatarsus, 0.26 mm; tarsus, 0.16 mm. Total length of male 1.3 mm. Carapace 0.68 mm long, 0.61 mm wide, 0.79 mm high. First patella and tibia 0.58 mm; second, 0.58 mm; third, 0.57 mm. Fourth femur, 0.66 mm; patella and tibia, 0.68 mm; metatarsus, 0.39 mm; tarsus, 0.23 mm.

Diagnosis. The coloration (Fig. 194), shape of the embolus (Fig. 198) and the epigynum and female genitalia (Figs. 196, 197) separate this species from *D. bryantae.*

Variation. The palpus of the male collected at Caraça has the median apophysis more swollen, and the radix behind the embolus lies against the median apophysis rather than standing up.

Records. Brazil. Minas Gerais: Caraça, ♀, ♂ (E. Gounelle, MNHN). *Santa Catarina:* Nova Teutonia, ♀ (F. Plaumann, SMF).

Dipoena bimini sp. n.

Figures 199-204

Type. Male holotype from South Bimini, Bahama Islands, 9-10 Dec. 1952 (A. M. Nadler), in the American Museum of Natural History. The specific name is a noun in apposition after the type locality.

Description. Carapace yellow; female with the cephalic area dusky; a dusky band continuing posteriorly is constricted in the thoracic area; sides dusky. Male with a dusky line on clypeus. Sternum yellow; legs yellow with indications of fine dusky bands on venter. Abdomen dorsum black with light marks (Fig. 199); venter lighter. Male carapace high, with dorsal grooves (Figs. 200, 201). Anterior median eyes slightly larger than others, two-thirds their diameter apart, almost touching laterals in female.

Posterior eyes two-thirds diameter apart. Total length of female 1.2 mm. Carapace 0.54 mm long, 0.54 mm wide. First patella and tibia 0.49 mm; second 0.44 mm; third 0.40 mm. Fourth femur 0.55 mm; patella and tibia 0.65 mm; metatarsus 0.35 mm; tarsus 0.31 mm. Total length of male 1.3 mm. Carapace 0.65 mm long; 0.52 mm wide, 0.65 mm high. First patella and tibia 0.52 mm; second 0.42 mm; third 0.42 mm. Fourth femur 0.52 mm; patella and tibia 0.59 mm; metatarsus 0.26 mm; tarsus 0.26 mm.

Diagnosis. The female genitalia (Figs. 202, 203) separate this species from *D. atlantica*. The palpus (Fig. 204) appears very different if only slightly turned.

Records. Bahama Islands: South Bimini, 9, 10 Dec. 1952, 2 ♀ paratypes (A. M. Nadler, AMNH); May 1951, 2 ♂ paratypes (W. J. Gertsch, M. A. Cazier, AMNH). *Cuba.* Oriente: S side of Pico Turquino, 1000-1500 m, June 1936, ♀ (P. J. Darlington).

Dipoena spinithorax (Keyserling)

Figures 205-208

Deliana spinithorax Keyserling, 1886, Die Spinnen Amerikas, Theridiidae, 2(2): 35, pl. 11, fig. 153, ♀. Female holotype from Tumbez [Tumbes], Peru, in the Polish Academy of Sciences, Warsaw, examined.

Description. Carapace dark red-brown. Sternum dark brown. Legs yellow with prolateral sides of first and second legs, and retrolateral sides of third and fourth brown. Coxae yellow-white. Abdomen shiny brownish black, a little lighter on venter. Carapace with an inconspicuous spine on thorax. Diameter of anterior median eyes more than twice that of other eyes. Anterior median eyes two-thirds diameter apart, almost touching laterals. Posterior eyes a little less than their diameter apart. Total lengh 2.3 mm. Carapace 0.90 mm long, 0.78 mm wide. First patella and tibia, 0.91 mm; second, 0.78 mm; third, 0.75 mm. Fourth femur, 0.91 mm; patella and tibia, 0.91 mm; metatarsus, 0.55 mm; tarsus, 0.36 mm.

Dipoena pumicata (Keyserling), new combination

Figures 209-218

Euryopis pumicata Keyserling, 1886, Die Spinnen Amerikas, Theridiidae, 2(2): 264, pl. 21, fig. 312, ♀. Female holotype from "Blumenau, Brasilien," however, type in British Museum, examined, is labelled as coming from Serra Vermelha, [Est. Rio de Janeiro].

Dipoena maculata Keyserling, 1891, Die Spinnen Amerikas, Brasilianische Spinnen, 3: 225, pl. 9, fig. 166, ♂. Male holotype from Espirito Santo on Rio Minas, Brazil, in the British Museum, examined. NEW SYNONYMY.

Carapace red-brown, legs red-brown except for yellow proximal portions. Abdomen blackish brown with symmetrical white spots (Fig. 209).

Comment. The epigynum of different specimens differs. The anterior dark areas are variable (Figs. 211, 213, 215). Females from Ceara, Matozinhos, and Tijuca have the opening more anterior (Fig. 211); other specimens, including the type, have the opening near the posterior border (Figs. 213, 215). A female from Caraça is intermediate in this respect.

Figures 214, 215 were made from the type of *Euryopis pumicata*, Figure 217 from the type of *D. maculata*.

Records. Brazil. Ceara: "Serra Communaty," ♀ (E. Gounelle, MNHN). *Bahia:* Biological Institute, Salvador, 28 Jan. 1959, ♂ (A. M. Nadler, AMNH). *Minas Gerais:* Matozinhos, ♀ (E. Gounelle, MNHN); Caraça, ♀ (E. Gounelle, MNHN). *Rio de Janeiro:* Teresópolis, ♀, ♂ (MNHN); Tijuca, ♀, ♂ (E. Gounelle, MNHN). *Mato Grosso.* ♂ (MNHN). *Santa Catarina:* Nova Teutonia, lat 27°11′ S, long 52°23′ W, ♀ (F. Plaumann, SMF); ♂ (F. Plaumann, ISNB).

Dipoena cornuta Chickering

Figures 219-222

Dipoena cornuta Chickering, 1943, Trans. Amer. Micros. Soc., 62: 344, figs. 20-23, ♀, ♂. Male holotype from Barro Colorado Isl., Panama Canal Zone, in the Museum of Comparative Zoology, examined.

Carapace, sternum dark brown. Legs yellow-white, with a narrow black line prolateral on first and second, retrolateral on third and fourth; abdomen black.

Additional Records. Nicaragua: Musawas, Waspuc River (B. Malkin, AMNH). *Panama Canal Zone:* Ft. Sherman; near Coccoli (A. M. Chickering). *Trinidad:* Simla near Arima (A. M. Nadler, AMNH). *British Guiana:* Kartabo, Bartica Distr., 1920, ♂ (W. Beebe, AMNH).

Dipoena tiro sp. n.

Figures 223-227

Type. Female holotype from northern Venezuela, "Caracas, San Estebán," 1887-1888 (E. Simon), in the Muséum National

d'Histoire Naturelle, Paris (no. 12631). The specific name is an arbitrary combination of letters.

Note. Although the exact type locality is not known, this species is described because it is very distinct. The female has been chosen as type since the most closely related species, *D. militaris*, also has a female type. The two species have been collected together and there is a slight possibility the males have been mixed up.

Description. Carapace rich, dark brown. Sternum olive-brown. Legs yellow with a black line along anterior face of all segments. Abdomen shiny brown, spinnerets yellow. Anterior median eyes have diameter more than twice that of others, in female two-thirds their diameter apart, touching laterals. Posterior median eyes one diameter apart, a little more than one from laterals. Anterior median eyes of male two-thirds diameter apart, almost touching laterals. Posterior eyes one and one-half diameters apart. Abdomen suboval, slightly pointed behind. Total length of female 2.2 mm. Carapace 0.85 mm long, 0.66 mm wide. First patella and tibia, 0.80 mm; second, 0.66 mm; third, 0.52 mm. Fourth femur, 0.78 mm; patella and tibia, 0.84 mm; metatarsus, 0.52 mm; tarsus, 0.28 mm. Total length of male 1.9 mm. Carapace 1.22 mm long, 0.78 mm wide, 0.91 mm high. First patella and tibia, 0.91 mm; second, 0.77 mm; third, 0.60 mm. Fourth femur, 0.80 mm; patella and tibia, 0.91 mm; metatarsus, 0.52 mm; tarsus, 0.36 mm.

Diagnosis. This species differs from *D. militaris* in that the epigynum has an anterior lip (Fig. 226), and in the male the carapace has a small pointed tip in center (Fig. 223) and the median apophysis has an apically directed projection (Fig. 227).

Records. ♀, 2 ♂ paratypes collected with type.

Dipoena trinidensis sp. n.
Figures 228-231

Type. Male holotype from Simla, near Arima, Trinidad, Lesser Antilles, 29-30 Dec. 1954 (A. M. Nadler), in the American Museum of Natural History. The specific name is an adjective after the island of the type locality.

Description. Carapace, sternum brown. Legs dusky gray. Abdomen with parchment-like integument, black with a white spot above spinnerets. Female abdomen quite high, subtriangular (Fig. 228). Carapace of male cylindrical with dorsal grooves as in *D. bimini*. Diameter of anterior median eyes almost twice

that of others, two-thirds diameter apart, almost touching laterals. Posterior median eyes of male two-thirds their diameter apart, two diameters from laterals; of female one-third diameter apart, their radius from laterals. Total length of female 1.8 mm. Carapace 0.71 mm long, 0.62 mm wide. First patella and tibia, 0.57 mm; second, 0.55 mm; third, 0.46 mm. Fourth femur, 0.65 mm; patella and tibia, 0.67 mm; metatarsus, 0.36 mm; tarsus, 0.26 mm. Total length of male 1.6 mm. Carapace, 0.78 mm long, 0.66 mm wide, 0.78 mm high. First patella and tibia, 0.55 mm; second, 0.55 mm; third 0.45 mm. Fourth femur, 0.65 mm; patella and tibia, 0.65 mm; metatarsus, 0.38 mm; tarsus, 0.26 mm.

Diagnosis. A ventral sclerite of the palpus (probably an accessory sclerite) has a large projection (Fig. 231) that distinguishes this species from *D. superba* and other related species. The white spot above the spinnerets (Fig. 228) separates the female from *D. donaldi*.

Record. Lesser Antilles. Trinidad: Simla near Arima, 26 Feb. 1959, ♀, ♂ paratypes (A. M. Nadler).

Dipoena barro sp. n.

Figures 232-234

Type. Female holotype from Barro Colorado Island, Panama Canal Zone, 16 July 1954 (A. M. Chickering), in the Museum of Comparative Zoology. The specific name is a noun in apposition after the type locality.

Description. Carapace, sternum, legs yellowish. Legs with some indistinct dusky bands. Abdomen with black and white spots on dorsum (Fig. 232). Anterior median eyes much larger than others, a little less than half their radius apart, almost touching laterals. Posterior median eyes their radius apart, two-thirds diameter from laterals. Total length 1.3 mm. Carapace 0.45 mm long, 0.53 mm wide. First patella and tibia 0.50 mm; second 0.50 mm; third 0.41 mm. Fourth femur 0.65 mm; patella and tibia 0.62 mm; metatarsus 0.31 mm; tarsus 0.26 mm.

Diagnosis. The epigynum and internal genitalia (Figs. 233, 234) and the spotted abdomen, which is almost as wide as long (Fig. 232), separate this species from *D. mertoni*.

Dipoena ira sp. n.

Figures 235-237

Type. Female holotype from Nova Teutonia, lat 27°11′ S, long 52°23′ W, Santa Catarina, Brazil (F. Plaumann), in the

Senckenberg Museum (no. RII/8131/1). The specific name is an arbitrary combination of letters.

Description. Carapace, sternum, yellow. Legs yellow with wide darker yellow rings. Dorsum of abdomen black, gray and white (Fig. 235); venter gray. Anterior median eyes slightly larger than others, not quite their diameter apart, almost touching laterals. Posterior median eyes their radius apart, two-thirds diameter from laterals. Abdomen wider than long (Fig. 235). Total length 2.0 mm. Carapace 0.72 mm long, 0.72 mm wide. First patella and tibia, 0.64 mm; second, 0.64 mm; third, 0.50 mm. Fourth femur, 0.69 mm; patella and tibia, 0.76 mm; metatarsus, 0.45 mm; tarsus 0.29 mm.

Diagnosis. Shorter connecting ducts (Fig. 236) separate this species from *D. hortoni,* the shape of the abdomen (Fig. 235) from *D. keyserlingi.*

Records. 2 ♀ paratypes from type locality.

Dipoena duodecimpunctata Chickering

Figures 238-241

Dipoena 12-punctata Chickering, 1943, Trans. Amer. Micros. Soc., 62: 348, figs. 27-29, ♂. Male holotype from Ft. Randolph, Panama Canal Zone, in the Museum of Comparative Zoology, examined.

This species is yellow-white except for black spots on the dorsum (Fig. 238). Venezuelan specimens are darker; the anterior half of the dorsum of the abdomen may be black, or the pattern may be as in *D. bequaerti* Chickering (Fig. 266).

Additional Records. Panama Canal Zone: Forest Reserve (A. M. Chickering). *Venezuela. Dist. Fed.:* Caracas, ♀ (E. Simon, MNHN). *Aragua:* Rancho Grande, ♀, ♂ (A. M. Nadler, AMNH); Tovar, ♀, ♂ (E. Simon, MNHN).

Dipoena keyserlingi nomen novum

Figures 242-243

Euryopis maculata Keyserling, 1891, Die Spinnen Amerikas, Brasilianische Spinnen, 3: 227, pl. 9, fig. 169, ♀. Female type from Miracena [Miracema, Rio de Janeiro], Brazil, in the British Museum, examined. Combination *Dipoena maculata* preoccupied by Keyserling, 1891, *op. cit.,* p. 225 [=*D. pumicata*]. The species is named after Count Keyserling, foremost student of South American theridiids.

The abdomen of this species has a pattern similar to that of *D. atlantica* (Fig. 150). The epigynum, however, is very distinct and the connecting ducts are shorter than those of *D. hortoni.*

Records. Brazil. Minas Gerais: Caraça, ♀ (E. Gounelle, MNHN).

Dipoena copiosa Levi
Figures 245-247

Dipoena copiosa Levi, 1953, Amer. Mus. Novitates, no. 1639: 3, figs. 14, 15, 27, 28, ♀. Female holotype from San José, Costa Rica, in the American Museum of Natural History.

The female carapace is high behind eyes (Levi, 1953a, fig. 15). Prosoma light brown. Dorsum of abdomen gray, with a white spot above spinnerets (Fig. 245). Venter black anterior to pedicel and between spinnerets and epigynum.

The Panamanian specimens are probably this species although the epigynum (Fig. 247) differs by having a longer anterior median portion of the duct than the type specimen (1953a, figs. 27, 28).

Additional Records. Panama Canal Zone: Chilibre, Experimental Gardens (both A. M. Chickering). *Brazil. São Paulo:* Forest Reservation, São Paulo (A. M. Nadler, AMNH).

Dipoena hortoni Chickering
Figures 250-253

Dipoena hortoni Chickering, 1943, Trans. Amer. Micros. Soc., 62: 352, figs. 32-35, ♂. Male holotype from Chilibre, Panama Canal Zone, in the Museum of Comparative Zoology, examined.

Carapace brownish, dusky on sides with a dusky cross; sternum gray; legs yellowish with black marks on venter. Abdomen with a black and white pattern (Fig. 250); venter gray.

Records. Trinidad. Arima Road, Gap in Blanchisseuse (A. M. Nadler, AMNH). *Venezuela. Aragua:* Rancho Grande (A. M. Nadler, AMNH). *Brazil. Pernambuco:* Recife (SMF).

Dipoena cordiformis Keyserling
Figure 244

Dipoena cordiformis Keyserling, 1886, Die Spinnen Amerikas, Theridiidae, 2(2): 259, pl. 21, fig. 307, ♂. Male holotype from Blumenau, [Santa Catarina], Brazil, in the British Museum, examined.

Carapace dark brown, legs yellow, abdomen brown-black.

Records. Panama Canal Zone: Barro Colorado Island (A. M. Chickering); Experimental Gardens (A. M. Chickering).

Dipoena sicki sp. n.
Figures 248-249

Type. Male holotype from Sumaré, Cidade Rio de Janeiro, Brazil, 200-300 m alt., Jan. 1946 (H. Sick), in the American Museum of Natural History. The species is named after Dr. H. Sick, Brazilian explorer and collector of the specimen.

Description. Carapace light orange with a broad black band enclosing eye region in front and going from clypeus to thoracic region. Sternum, legs, light orange. Dorsum of abdomen white with a black pattern (Fig. 248), venter white. Carapace low, without grooves. Anterior median eyes slightly larger than others, their radius apart. Posterior median eyes their radius apart, two-thirds diameter from laterals. Total length 1.5 mm. Carapace 0.65 mm long, 0.65 mm wide. First femur 0.67 mm; patella and tibia 0.75 mm; metatarsus 0.47 mm; tarsus 0.26 mm. Second patella and tibia 0.67 mm; third 0.57 mm; fourth 0.71 mm.

Diagnosis. The distinctive embolus of the palpus (Fig. 249) separates this species from other *Dipoena.*

Dipoena augara sp. n.
Figures 254-256

Type. Female holotype from Tavara, Aragua, Venezuela, 1888 (E. Simon), in the Muséum National d'Histoire Naturelle, Paris (no. 14552). The specific name is an anagram of the type locality as a noun in apposition.

Description. Carapace dusky brown. Sternum gray. Legs yellow with many narrow black rings that are broken dorsally. Abdomen gray with indistinct but symmetrical white spots on dorsum (Fig. 254) and even gray on venter. Anterior median eyes slightly larger than others, one-third their diameter apart, one-quarter diameter from laterals. Posterior median eyes their radius apart, their diameter from laterals. Abdomen wider than long (Fig. 254). Total length 1.8 mm. Carapace 0.69 mm long, 0.65 mm wide. First patella and tibia, 0.60 mm; second, 0.63 mm; third, 0.59 mm. Fourth femur, 0.75 mm; patella and tibia, 0.83 mm; metatarsus, 0.44 mm; tarsus, 0.29 mm.

Diagnosis. The elaborate coil of the ducts (Fig. 255) separates this species from most *Dipoena.* The much narrower entrance to the ducts, as visible in the epigynum (Fig. 256), separates *D. augara* from *D. meckeli* Simon.

Dipoena meckeli Simon
Figures 257-258

Dipoena meckeli Simon, 1897, Proc. Zool. Soc. London, p. 863. Female holotype from St. Vincent Island, Lesser Antilles, in the British Museum, examined.

The legs are banded and the abdomen has a pattern. This species is very small and the genitalia of the type specimen were difficult to study. The coiled connecting ducts are diagnostic.

Dipoena tropica Chickering
Figures 259-262

Dipoena tropica Chickering, 1943, Trans. Amer. Micros. Soc., 62: 375, figs. 64-66, ♂. Male holotype from Chilibre, Panama Canal Zone, in the Museum of Comparative Zoology, examined.

Description. Female: carapace dusky brown, legs yellowish. Abdomen dusky around dorsum with a pattern (Fig. 259), venter lighter. Anterior median eyes slightly larger than others, their radius apart, almost touching laterals. Posterior median eyes one-third their diameter apart, their radius from laterals. Total length 1.4 mm. Carapace 0.53 mm long, 0.53 mm wide. First patella and tibia 0.53 mm; second 0.52 mm; third 0.52 mm. Fourth femur 0.65 mm; patella and tibia 0.68 mm; metatarsus 0.43 mm; tarsus 0.27 mm.

Diagnosis. The epigynum (Fig. 261) has a posterior projecting knob with an opening. Below the knob along the dorsal edge is an elongate transverse plate, which is shown in the cleared epigynum (Fig. 260).

Additional Records. Panama: Arraiján (A. M. Chickering). *Panama Canal Zone:* Summit (A. M. Chickering).

Dipoena banksi Chickering
Figures 263-265

Dipoena banksi Chickering, 1943, Trans. Amer. Micros. Soc., 62: 337, figs. 10-13, ♀, ♂. Male holotype from Forest Reserve, Panama Canal Zone, in the Museum of Comparative Zoology, examined.

Dipoena schmidti Levi, 1953, Amer. Mus. Novitates, no. 1639: 9, figs. 25, 26, ♀. Female [not male] holotype from San José, Costa Rica, in the American Museum of Natural History. NEW SYNONYMY.

This species is brownish black, with the legs slightly lighter. The abdomen is suboval.

Distribution. Costa Rica to Venezuela.

Additional Records. Panama Canal Zone: Barro Colorado Island; Chiva Road near Pedro Miguel (All A. M. Chickering). *Panama:* El Volcán (A. M. Chickering). *Venezuela. Carabobo:* San Estebán, 1888, ♀ (E. Simon, MNHN).

Dipoena bequaerti Chickering
Figures 266-267

Dipoena bequaerti Chickering, 1948, Trans. Amer. Micros. Soc., 67: 331, figs. 1-3, ♂. Male holotype from Ft. Sherman, Panama Canal Zone, in the Museum of Comparative Zoology, examined.

Carapace, sternum, yellow-brown; legs yellow with sides of femora darker. Dorsum of abdomen flecked with white and black (Fig. 266); venter gray.

Dipoena orvillei Chickering
Figures 268-271

Dipoena orvillei Chickering, 1943, Trans. Amer. Micros. Soc., 62: 360, figs. 44, 45, ♂. Male holotype from El Valle, Panama, in the Museum of Comparative Zoology, examined.

Description. Female. Carapace dark dusky brown, sternum dusky, legs brown. Abdomen black except a white spot above spinnerets (Fig. 268). Eyes subequal in size. Anterior median eyes two-thirds their diameter apart almost touching laterals. Posterior median eyes one-third diameter apart, one-third diameter from laterals. Total length of female 1.7 mm. Carapace 0.71 mm long, 0.71 mm wide. First patella and tibia 0.75 mm; second 0.70 mm; third 0.65 mm.

Diagnosis. The opening of the epigynum is in a sclerotized patch (Fig. 270). Unlike *D. banksi* the sclerotized area is some distance from the posterior margin.

Records. Panama: El Valle, ♀, ♂ (A. M. Chickering).

Dipoena pacifica Chickering
Figures 272-276

Dipoena pacifica Chickering, 1943, Trans. Amer. Micros. Soc., 62: 361, figs. 46-49, ♀, ♂. Male holotype from El Valle, Panama, in the Museum of Comparative Zoology, examined.

This lightly colored species has the clypeus black, a black border around the carapace, and the sides of the abdomen black (Fig. 272).

Additional Record. British West Indies. Jamaica: St. Ann Parish (P. Park).

Dipoena liguanea sp. n.

Figures 277-280

Type. Male holotype from Liguanea, St. Andrew Parish, Jamaica, British West Indies, Oct. 1957 (A. M. Chickering), in the Museum of Comparative Zoology. The specific name is a noun in apposition after the type locality.

Description. Carapace dark grayish brown, sternum gray, legs white with black patches or bands. Abdomen with a median dorsal gray band on mottled white background; sides of abdomen black, a white line above spinnerets (Fig. 277); venter white. Anterior median eyes slightly larger than others, their radius apart, almost touching laterals. Posterior median eyes less than their diameter apart, less than a diameter from laterals in female, slightly more than their diameter in male. Carapace of male very high with grooves (Fig. 277). Total length of female 1.6 mm. Carapace 0.53 mm long, 0.53 mm wide. First patella and tibia 0.50 mm; second 0.45 mm; third 0.45 mm. Fourth femur 0.52 mm; patella and tibia 0.57 mm; metatarsus 0.28 mm; tarsus 0.26 mm. Total length of male 1.4 mm. Carapace 0.71 mm long, 0.57 mm wide, 0.57 mm high. First patella and tibia 0.54 mm, second 0.47 mm, third 0.45 mm. Fourth femur 0.52 mm; patella and tibia 0.60 mm; metatarsus 0.39 mm; tarsus 0.26 mm.

Diagnosis. Unlike other West Indian species, *D. liguanea* females have two separate openings in an anterior sclerotized area (Fig. 279); and the palpus has the visible portion of the median apophysis swollen (Fig. 280).

Records. British West Indies. Jamaica. St. Catherine Parish: W of Spanish Town, Oct., Nov. 1957 (A. M. Chickering). St. Andrew Parish: Liguanea, 2 ♀ paratypes, Oct. 1957 (A. M. Chickering); Blue Mountains, Hardwar Gap (A. M. Chickering; A. M. Nadler, AMNH); Dolphin Head (A. M. Nadler, AMNH).

Dipoena isthmia Chickering

Figures 281-284

Dipoena isthmia Chickering, 1943, Trans. Amer. Micros. Soc., 62: 357, figs. 40-41, ♂. Male holotype from Chilibre, Panama Canal Zone, in the Museum of Comparative Zoology, examined.

Description. Female. Carapace, legs, dusky yellow. Sternum dusky. Abdomen with dorsum black, gray and white with pattern (Fig. 281); venter gray. Carapace large and massive, highest in

thoracic region, gently sloping down from thorax to eyes. Anterior median eyes much larger than others, their diameter apart, a little less than one-quarter diameter from laterals. Posterior median eyes their radius apart, one and one-half diameters from laterals. Total length 2.5 mm. Carapace 0.98 mm long, 0.91 mm wide, 0.71 mm high. First femur 1.04 mm; patella and tibia 1.14 mm; metatarsus 0.76 mm; tarsus 0.34 mm. Second patella and tibia 0.82 mm; third 0.73 mm; fourth 1.03 mm.

The female is matched to the male because of similar coloration; however, the female is much larger than the male.

Record. Panama Canal Zone: Chilibre, 8 July 1950, ♀ (A. M. Chickering).

Dipoena tingo sp. n.

Figures 285-287

Type. Female holotype from Tingo María, Huánuco, Peru, 20 Jan. 1947 (J. C. Pallister), in the American Museum of Natural History. The specific name is a noun in apposition after the type locality.

Description. Carapace, sternum, legs, orange-yellow. Abdomen orange-yellow with some darker orange spots on back (Fig. 285). Eyes subequal in size. Anterior median eyes two-thirds diameter apart, one-quarter diameter from laterals. Posterior median eyes their diameter apart. Total length 1.6 mm. Carapace 0.65 mm long, 0.65 mm wide. First patella and tibia 0.59 mm; second 0.53 mm; third 0.40 mm. Fourth femur 0.62 mm; patella and tibia 0.61 mm; metatarsus 0.31 mm; tarsus 0.27 mm.

Diagnosis. The location of the epigynum opening at the posterior margin (Fig. 287) separates this species from others that have a sclerotized area anterior on the epigynum.

Dipoena pallisteri sp. n.

Figures 288-291

Type. Female holotype from Mandor near Quillabamba, Cuzco, Peru, 15 March 1947 (J. C. Pallister), in the American Museum of Natural History. This species is named after the collector.

Description. Carapace, sternum black. Legs probably black with proximal portions of femora white. Dorsum of abdomen white and black with a pattern (Fig. 289), sides black, venter with two white spots anterior of pedicel (Fig. 288). Anterior median eyes much larger than others, three-quarters diameter

apart, almost touching laterals. Posterior median eyes their radius apart, one and one-half diameters from laterals. Total length 2.2 mm. Carapace 0.91 mm long, 0.78 mm wide. First patella and tibia 1.18 mm.

Diagnosis. The epigynum (Fig. 291), with its three pockets, separates this species from most other *Dipoena*. The white spots on the venter (Fig. 288) and shorter connecting ducts (Fig. 290) separate *D. pallisteri* from *D. foliata*.

Dipoena foliata Keyserling

Figures 292-296

Dipoena foliata Keyserling, 1886, Die Spinnen Amerikas, Theridiidae, 2(2): 260, pl. 21, fig. 308, ♀. Female holotype from Blumenau, [Santa Catarina], Brazil, in the British Museum, examined.

Carapace, sternum, red-brown. Legs yellow with distal ends of segments of fourth leg brown. Abdomen brown below, sides black; dorsum grayish white with indistinct longitudinal band consisting of black spots (Fig. 292).

Records. Brazil. Santa Catarina: Nova Teutonia, lat 27°11′ S, long 52°23′ W, ♀, ♂ (F. Plaumann, SMF).

Dipoena itu sp. n.

Figures 297-298

Type. Male holotype from Itú, Est. São Paulo, Brazil, 14 Jan. 1959 (A. M. Nadler), in the American Museum of Natural History. The specific name is a noun in apposition after the type locality.

Description. Carapace, sternum, reddish brown. Legs yellow-brown, coxae and proximal portions of femora light yellowish. Abdomen black. Carapace slightly corniculate, with eyes on a bulging projection, and a deep transverse thoracic groove (Fig. 297). Diameter of anterior median eyes more than twice that of other eyes. Anterior median eyes one diameter apart, almost touching laterals. Posterior median eyes one diameter apart, a little more than one diameter from laterals. Abdomen subtriangular. Total length 2.1 mm. Carapace 1.04 mm long, 0.73 mm wide. First femur, 0.80 mm; patella and tibia, 0.88 mm; metatarsus, 0.63 mm; tarsus, 0.31 mm. Second patella and tibia, 0.66 mm; third, 0.55 mm; fourth, 0.69 mm.

Diagnosis. The structure of the palpus (Fig. 298), the large anterior median eyes, and the shape of the carapace separate this species from other *Dipoena*.

Dipoena inca sp. n.
Figures 299-301

Type. Male holotype from Monzón Valley, Tingo María, Huánuco, Peru, 10 Oct. 1954 (E. I. Schlinger, E. S. Ross), in the California Academy of Sciences. The specific name is a noun in apposition after the Inca civilization.

Description. Carapace, sternum, legs, orange-yellow. Abdomen white. Carapace very high with dorsal grooves (Figs. 299, 300). Anterior eyes slightly larger than others, three-quarters diameter apart, almost touching laterals. Posterior median eyes a little more than their diameter apart, one diameter from laterals. Abdomen short, subtriangular, higher than long. Total length 2.9 mm. Carapace 0.80 mm long, 0.68 mm wide, 0.72 mm high. First femur 0.62 mm; patella and tibia 0.58 mm; metatarsus 0.28 mm; tarsus 0.21 mm. Second patella and tibia 0.52 mm; third 0.45 mm; fourth 0.55 mm.

Diagnosis. The distinctive palpus, with its unusual three-pronged sclerite on the tegulum (Fig. 301), separates this species from other *Dipoena*.

Dipoena granulata (Keyserling), new combination
Figures 302-303

Umfila granulata Keyserling, 1886, Die Spinnen Amerikas Theridiidae, 2(2): 257, pl. 20, fig. 305, ♂. Male holotype from Blumenau, [Santa Catarina], Brazil, in the British Museum, examined.

Carapace orange, legs yellow with ends of segments darker. Abdomen yellow with a black pattern (Fig. 302).

Comment. This species, probably a *Dipoena*, may be close to *Euryopis spinigera*. Unlike *Euryopis* species, it has two colulus setae.

Records. Brazil. Minas Gerais: Vicosa, 6 July 1933 (Hambleton, AMNH).

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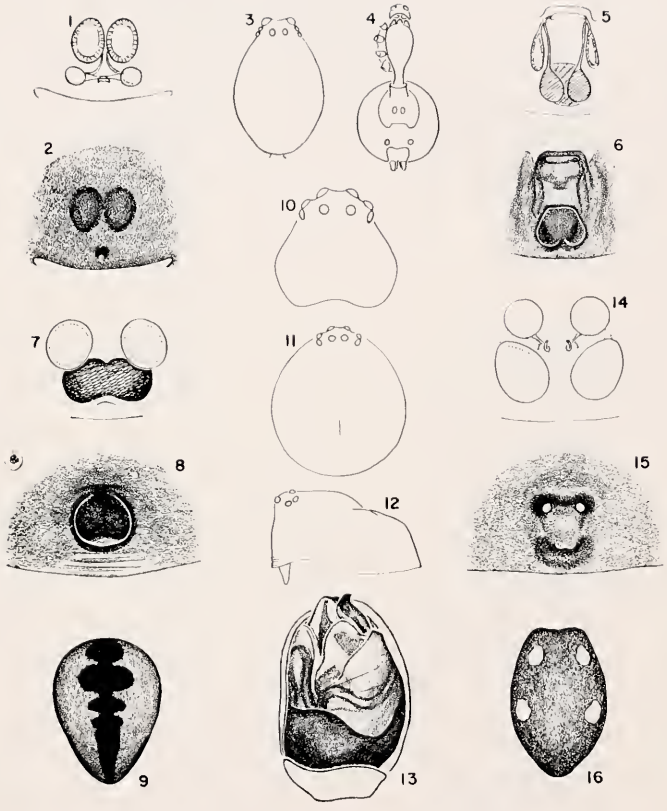
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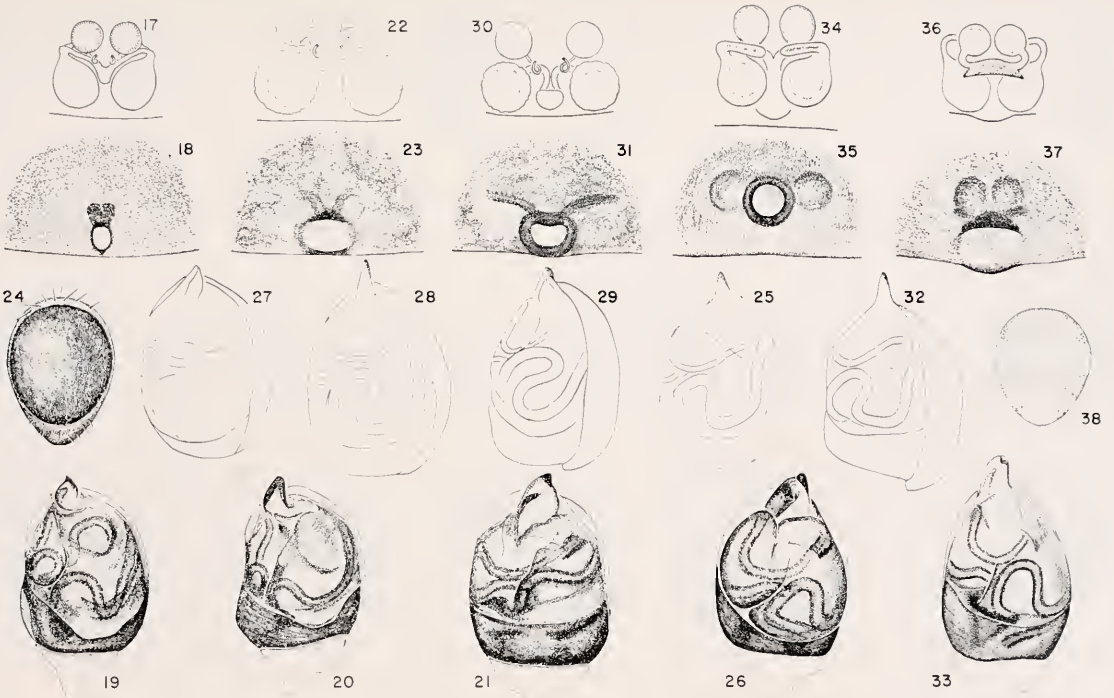
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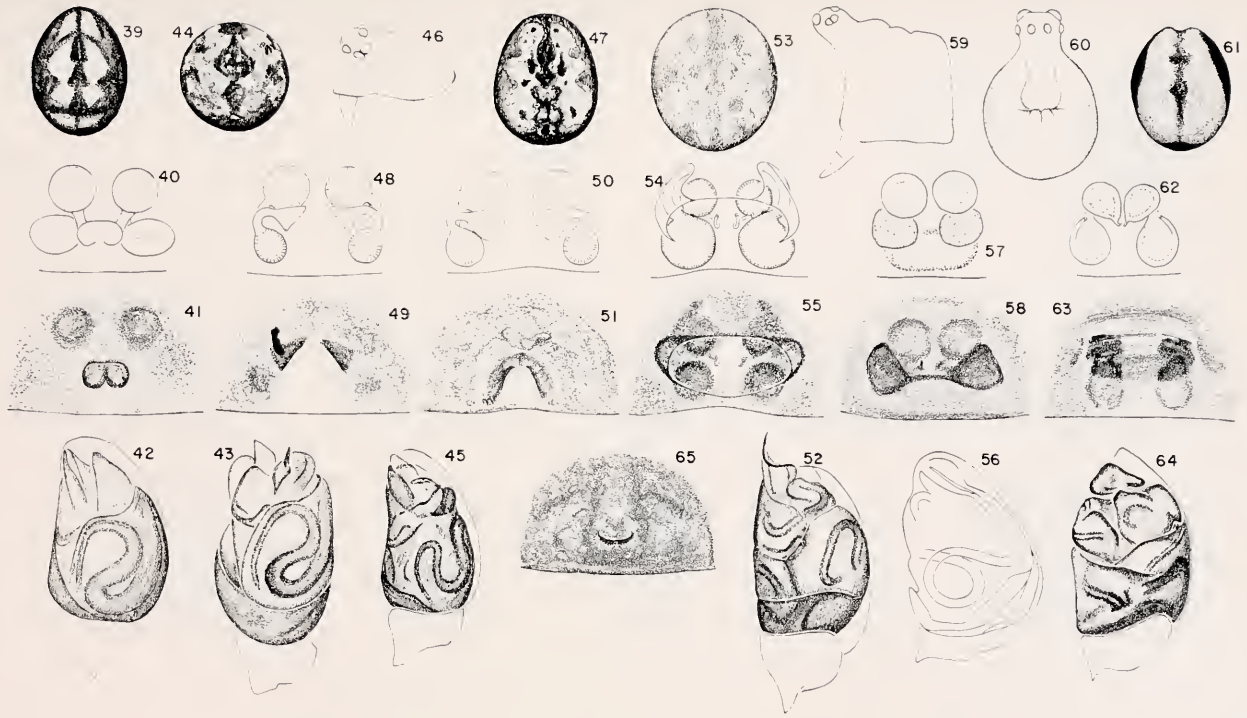
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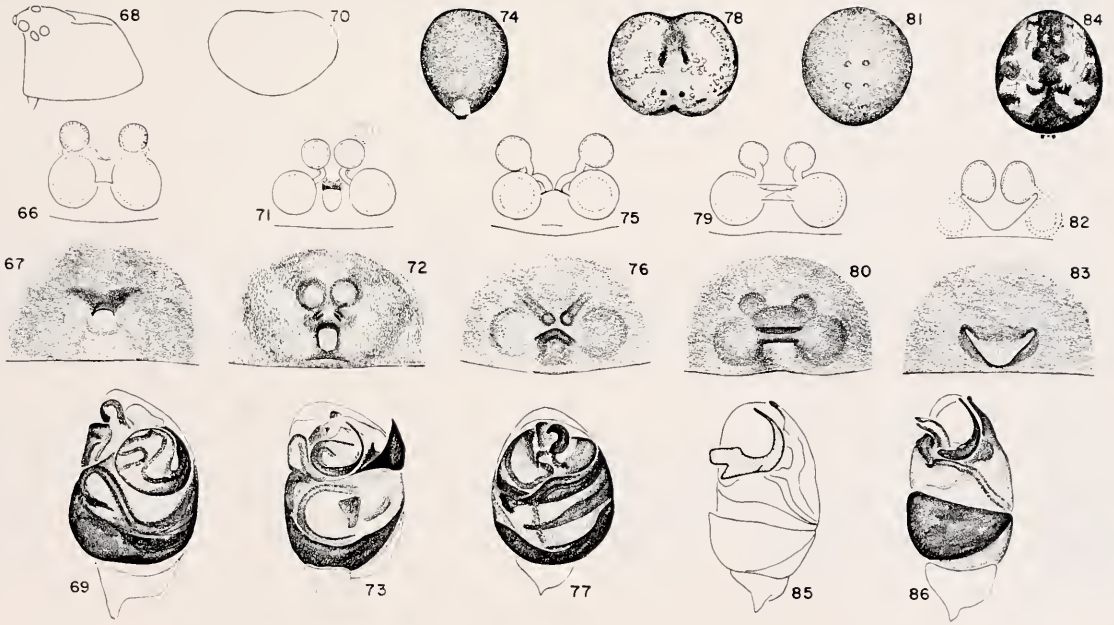
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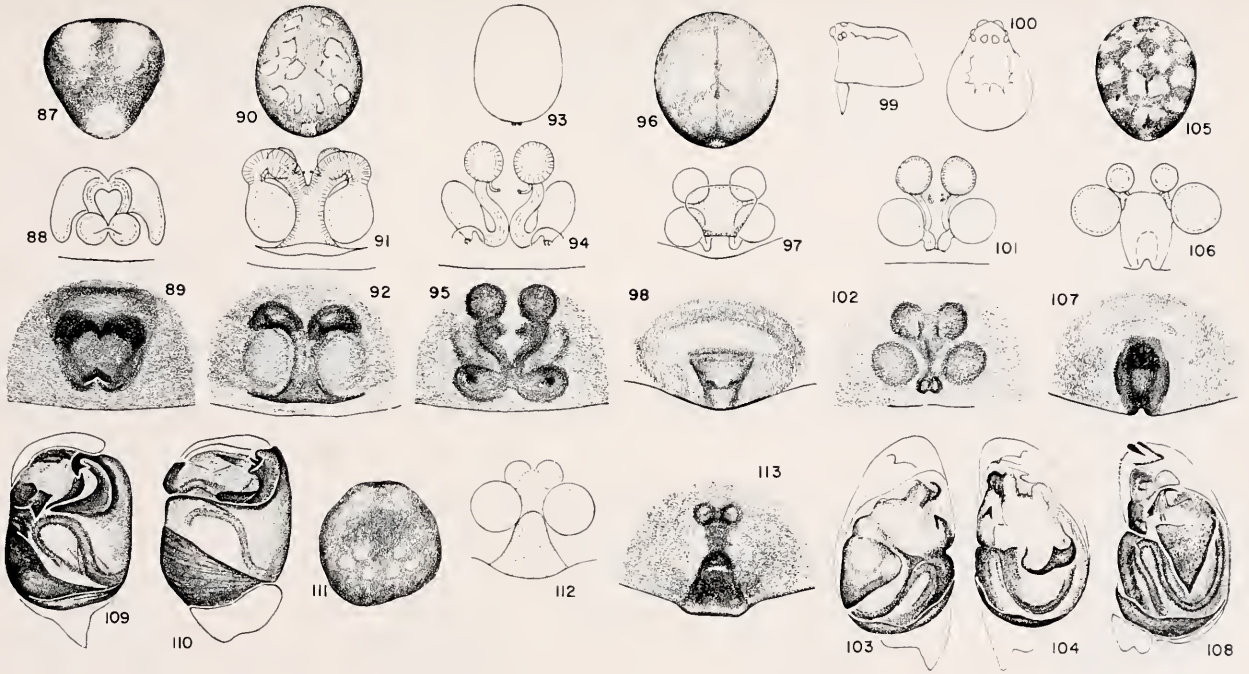
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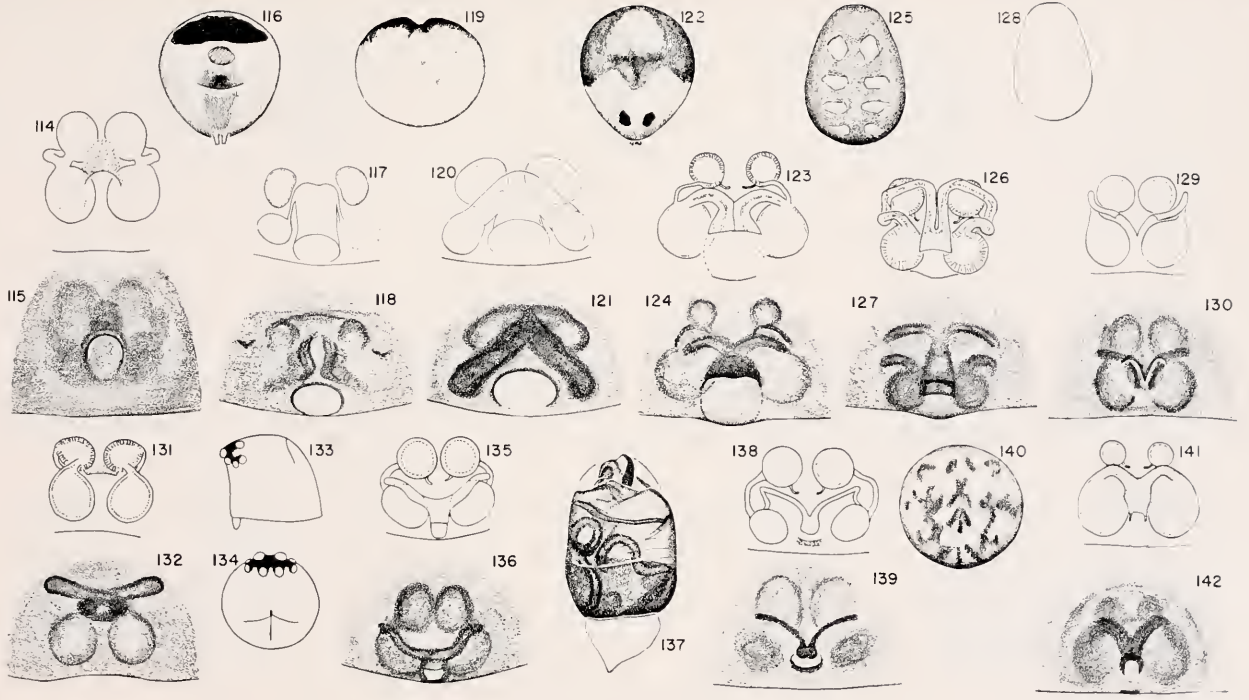
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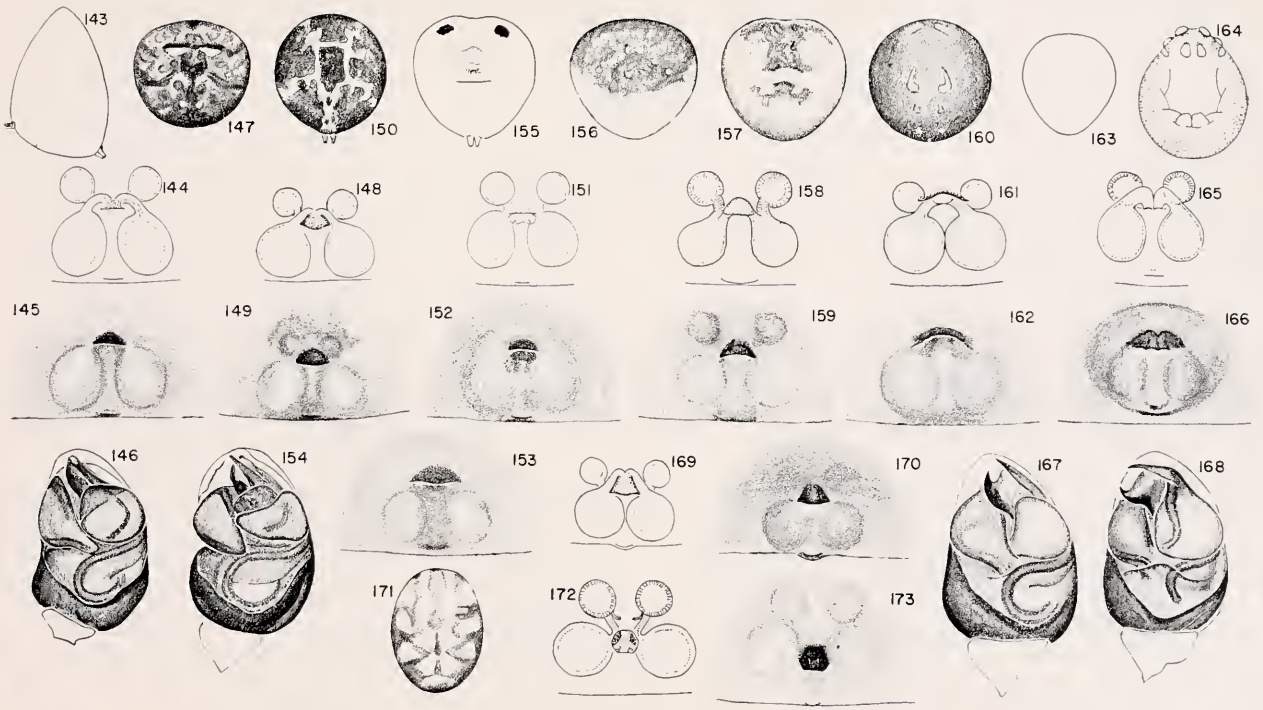
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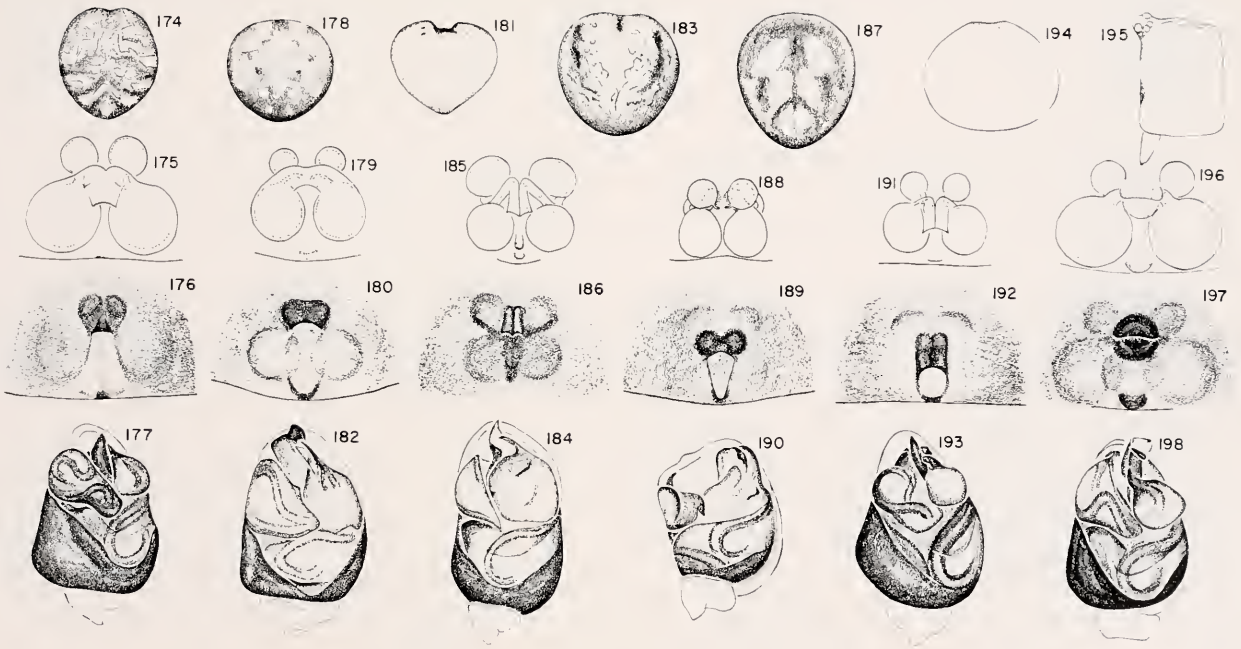
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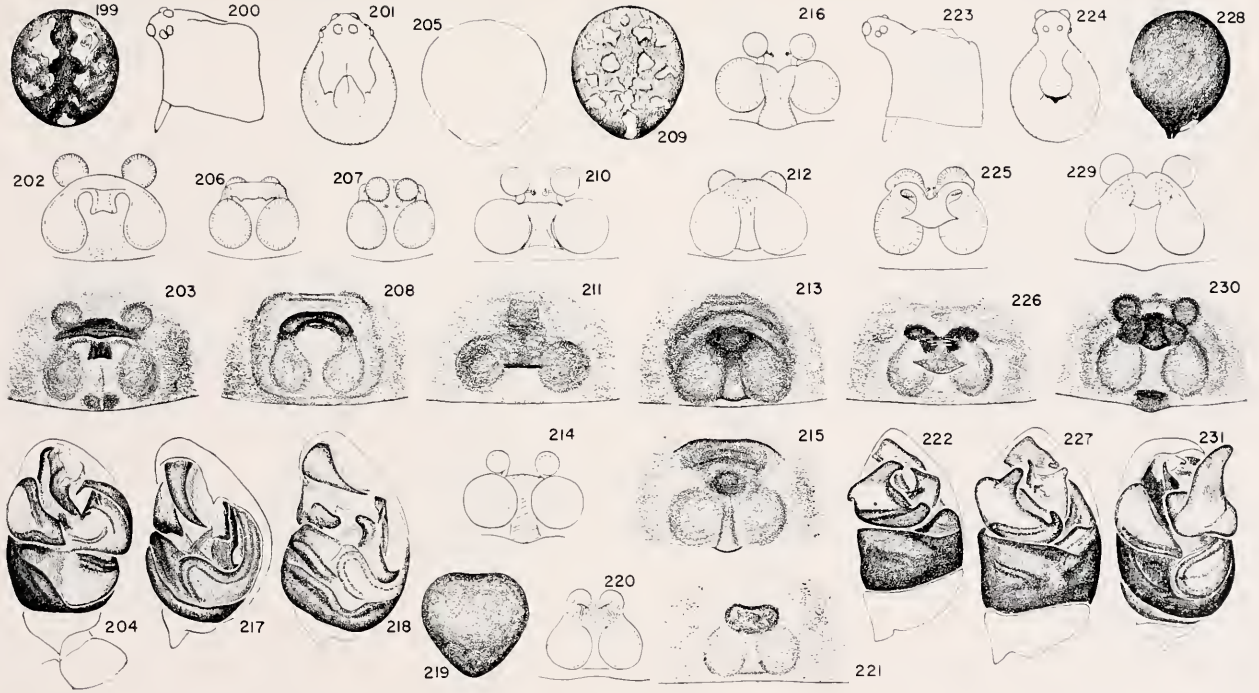
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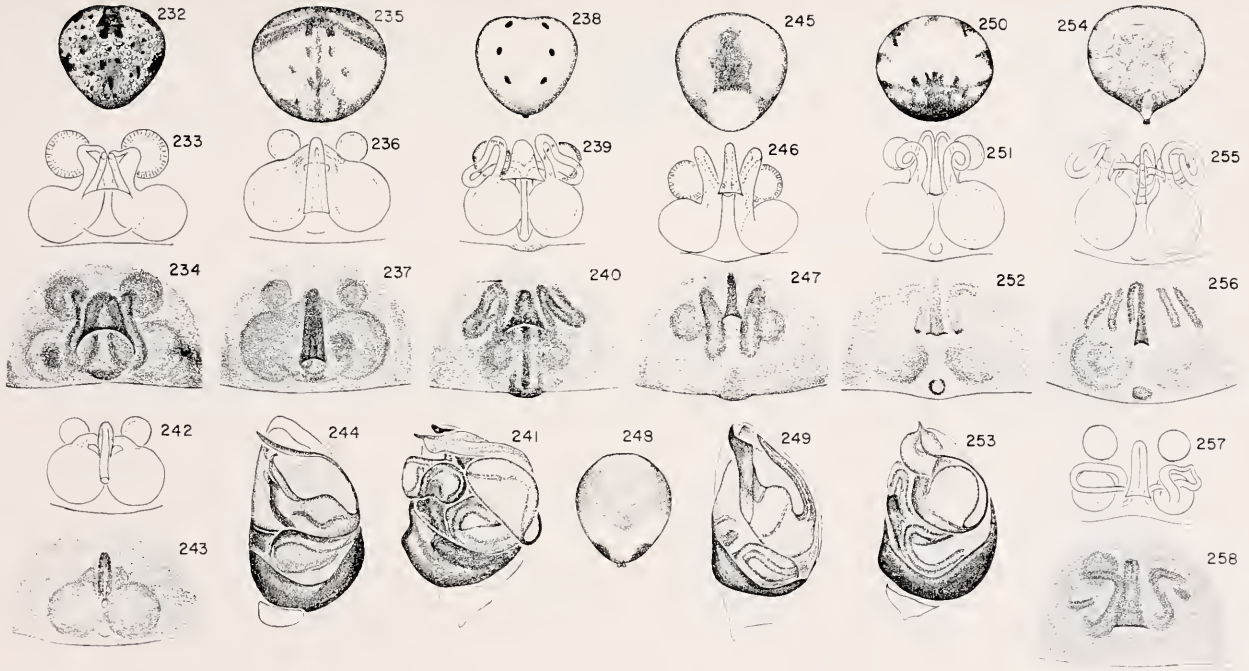
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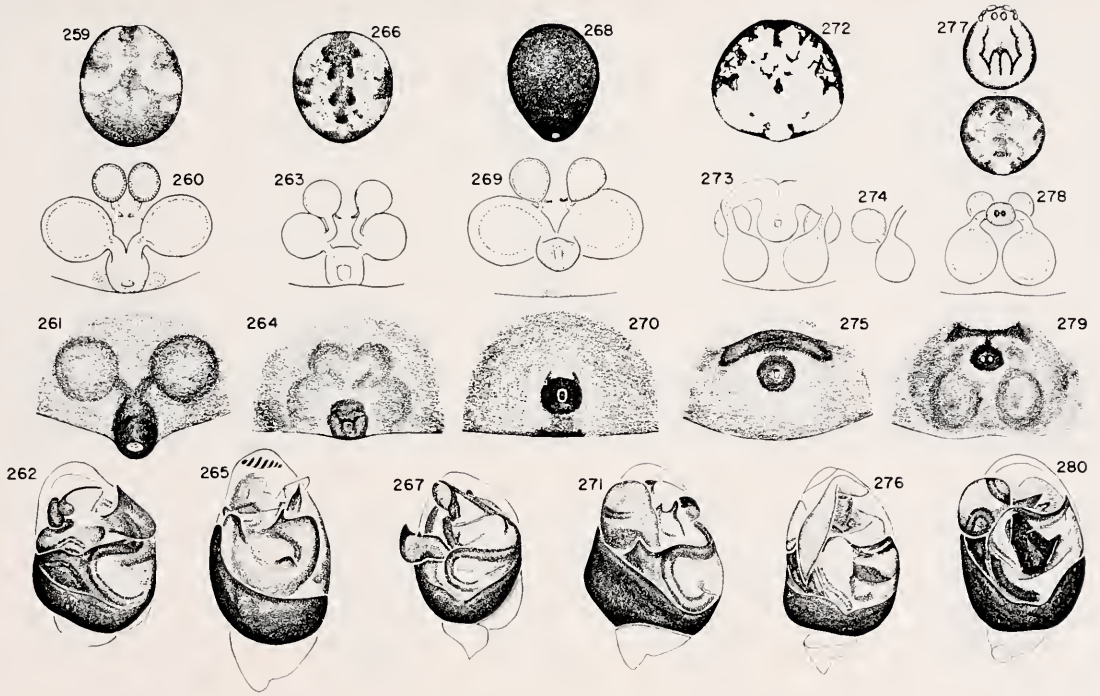
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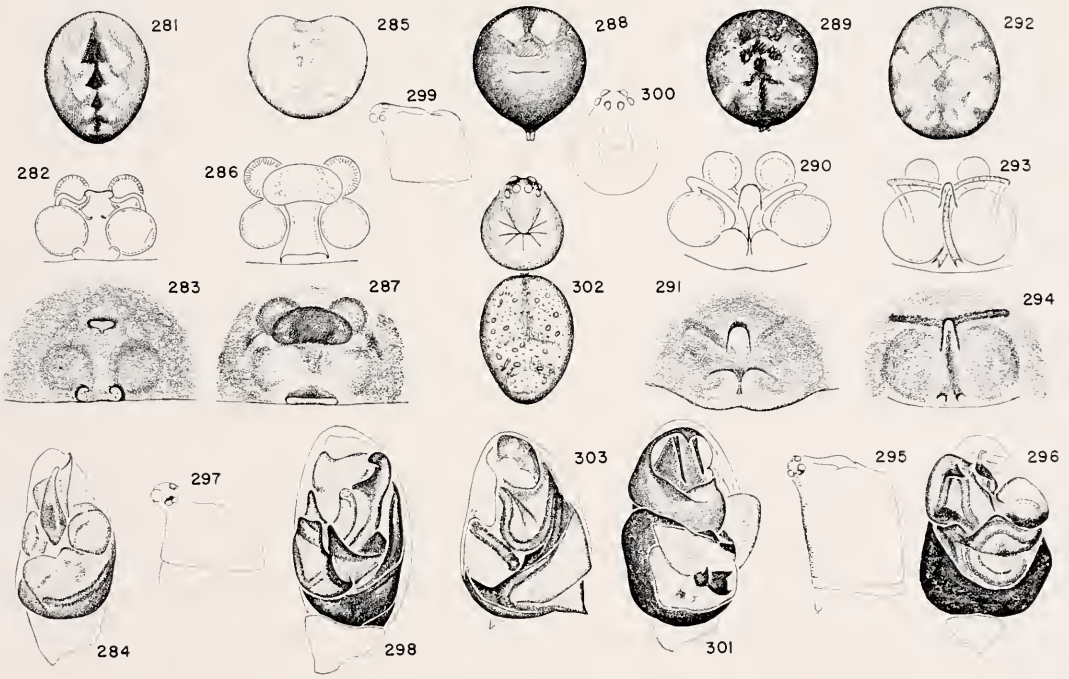
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Bulletin of the Museum of Comparative Zoology
AT HARVARD COLLEGE
Vol. 129, No. 3

AMERICAN SPIDERS OF THE GENUS *ACHAEARANEA* AND THE NEW GENUS *ECHINOTHERIDION* (ARANEAE, THERIDIIDAE)

By Herbert W. Levi

WITH FIVE PLATES

CAMBRIDGE, MASS., U.S.A.
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No. 3—*American Spiders of the Genus* Achaearanea *and the new Genus* Echinotheridion (*Araneae, Theridiidae*)

By Herbert W. Levi

In two previous papers (1955, 1959) I revised *Achaearanea* species of North and Central America. Since then, most of the types of South American species have been examined and large collections have become available from South America. This paper provides a key to all American species and indicates diagnostic characters for the species not included in my previous papers. One additional new species has been discovered in the United States, the male of another is described for the first time, and one other from Central America was previously missed because it had been placed in the wrong genus. Also, several errors were discovered in my earlier paper on Central American spiders: Several species previously thought to be similar but distinct were found, upon examination of additional specimens, to be conspecific, as the characters thought to separate them are variable. This was found for the species here synonymized in *A. taeniata*, *A. nigrovittata* and *A. tessclata*.

Several problems remain. Sometimes *Achaearanea* species are difficult to separate from *Theridion*, particularly when only females are known, or when there are too few males available for a careful anatomical examination. The other problem is that several species previously known only from a restricted area may be cosmopolitan or cosmotropical. Thus a longer-used name may be applicable to *A. acoreensc*, now known from the Mediterranean and California and possibly also from New Zealand, and for *A. tessclata* from Mexico to Paraguay and also probably identified from New Guinea and Pakistan. Another is well known to be cosmopolitan, *A. tepidariorum*. The latter species probably has been transported by man. It may, however, have been native to South America, where it is found in cities but has also been collected in fields. But ecological information on this and other South American species is scant.

Four similar species, superficially close to *Achaearanea*, are placed in a new genus even though it is inadvisable to describe a new genus from one sex only. No males could be associated with the four; all are known from females only. All have a very distinctive large epigynum and a mesally-directed thorn on the fourth coxae, apparently a functional part associated with the

epigynum. A thorn is present on leg four of the European *Theridion bimaculatum* (also found in northwestern United States), but is on the proximal end of the femur and has a different appearance. *Theridion bimaculatum* is further distinct in having the legs much longer than those of the species now placed in *Echinotheridion*.

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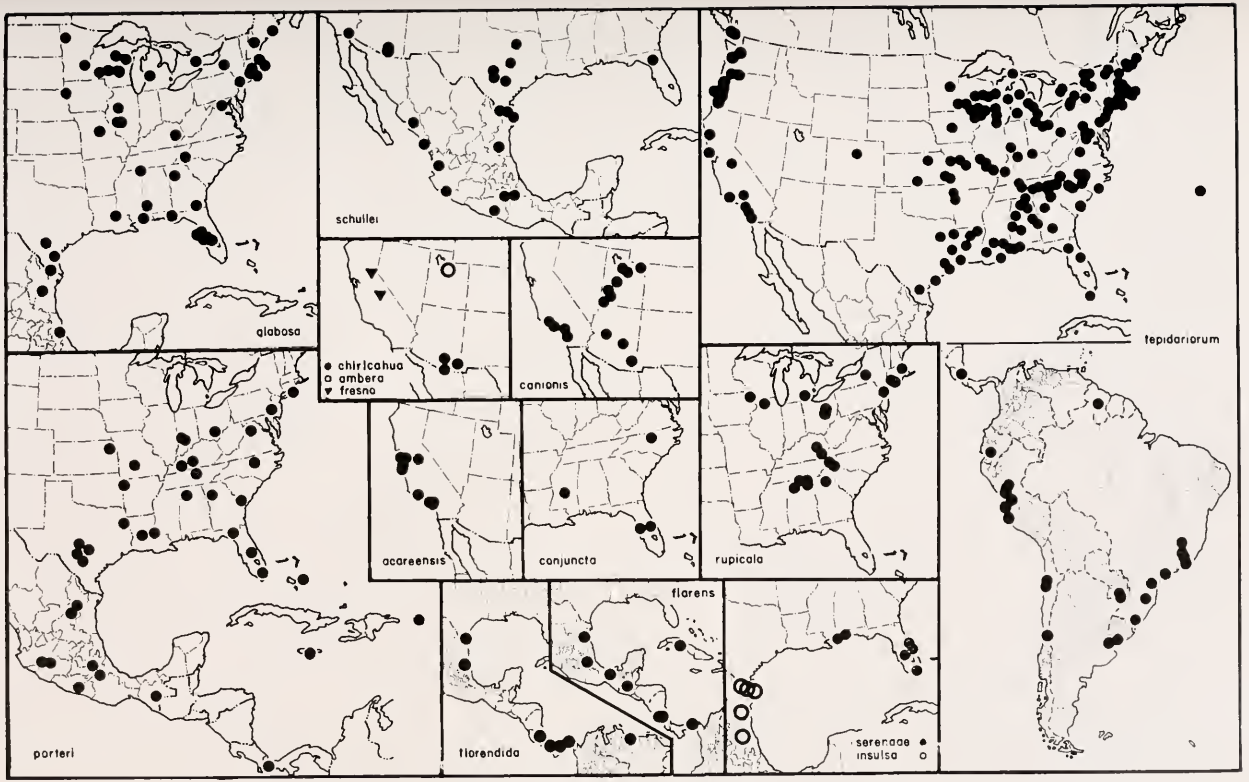
A paper in press discusses the location of the many difficult to find old type localities in South America.

Achaearanea Strand

Achaea O. P.-Cambridge, 1882, Proc. Zool. Soc. London, p. 428. Type species by monotypy *A. insignis* O. P.-Cambridge, 1882 [*A. trapezoidalis* (Taczanowski)]. Homonym of *Achaea* Huebner, 1823.

Achaearanea Strand, 1929, Acta Univ. Latviensis, 20: 11. New name for *Achaea* O. P.-Cambridge preoccupied.



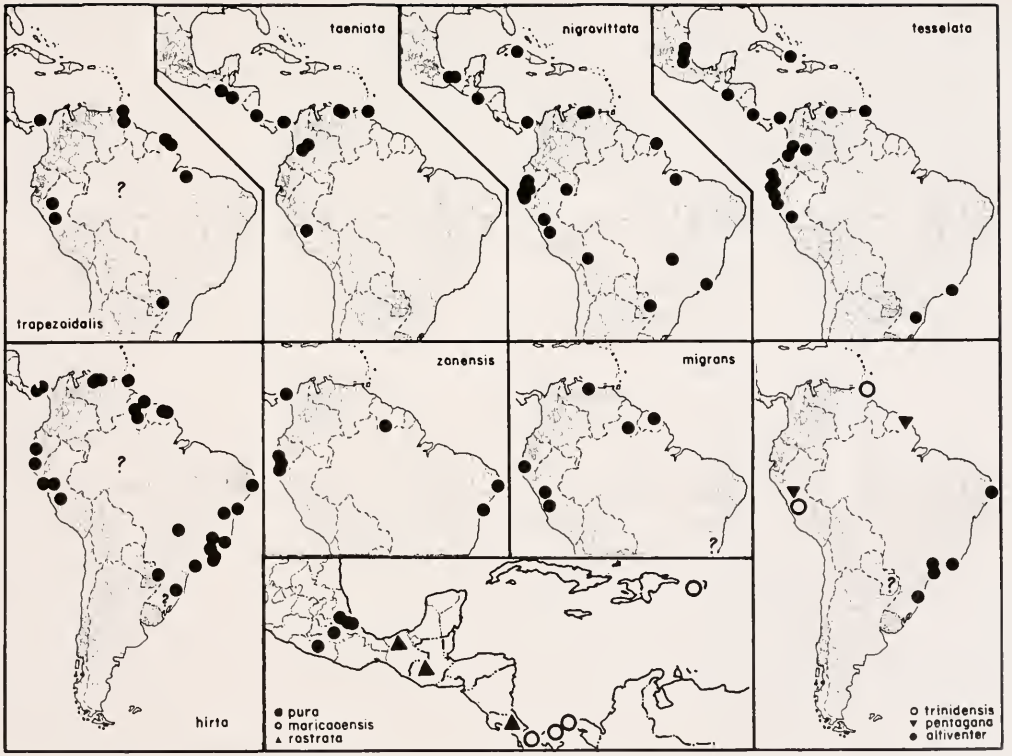
Map 1. Distribution of *Achaearanea* species occurring in Canada and the United States.

Diagnosis. The median apophysis of the palpus is broadly attached to the tegulum or attached to the embolus, with which it may form one sclerite. The radix is absent. The cymbium often extends beyond the alveolus. *Theridion* differs by having median apophysis and embolus as separate sclerites and radix usually present. Unlike *Theridion* the abdomen of many species is higher than long, often with a hump, rarely longer than high, very rarely subspherical as is common in *Theridion*. Unaccompanied females, however, cannot always be separated with certainty from related genera (Levi and Levi, 1962).

Distribution. Three species might be cosmopolitan (*A. tepidariorum*, *A. acoreensis*, and *A. tesselata*). Fourteen species are known from the United States and Canada but only the cosmopolitan *A. tepidariorum* is found from coast to coast. Four species are mainly eastern (*A. globosa* to northeastern Mexico, *A. porteri* to Panama, *A. rupicola* to northern Alabama and Georgia, *A. conjuncta* southeastern states), five are western (*A. canionis* Utah, Arizona and California, *A. acoreensis* California and probably cosmopolitan, *A. ambera* Utah, *A. chiricahua* Arizona, and *A. fresno* central California), and three are southern (*A. schullei* is southern from Florida to California and Mexico, *A. insulsa* Texas and Mexico and *A. serenoae* Florida and Alabama; Map 1).

Achacaranea florens occurs from northwestern Mexico, Cuba to Panama (Map 1); *A. maricaoensis* is found in Puerto Rico and Panama; and *A. rostrata* from southern Mexico to Costa Rica (Map 2). There is one endemic species on Cuba, one on Jamaica, five in Mexico, and five in Central America.

Nine species of *Achacaranea* are widespread in South America. The cosmopolitan *A. tepidariorum* is found as far south as Chile and Argentina (Map 1). None of the other widespread species have been found in Chile. *Achacaranea florendida* is found from Texas to Venezuela (Map 1); *A. taeniata* and *A. migrans* are mainly northern South America; *A. hirta*, *A. tesselata*, *A. zonensis*, *A. trapezoidalis* and *A. nigrovittata* occur from Mexico or Panama to eastern or southern Brazil (Map 2). Few collections were available from Argentina, which accounts for the lack of records. *Achacaranea trinidensis* is known from Trinidad and Peru, *A. pentagona* from Guianas and Peru (Map 2). Three species have been collected along the Brazilian coast (*A. altiventer*, *A. cinnabarina*, and *A. bellula*) and thirty-six species are endemic or rare and are known from only few records: two from Guianas and northwestern Brazil, two from Venezuela, one from Venezuela and Colombia, two from Colombia and Ecuador, one from



Map 2. Distribution of some Mexican, Central and widespread South American *Achaearanea* species.

eastern Brazil, eleven from Ecuador and Peru, fifteen from southeastern and southern Brazil to Paraguay, and two from Chile.

Misplaced species.

Achaea acutiventer Keyserling = *Coleosoma acutiventer* (Keyserling)

Achaea compressa Keyserling = *Chrysso compressa* (Keyserling)

Achaea crocea O. P.-Cambridge = *Dipoena crocea* (O. P.-Cambridge)

Achaea pulchra Keyserling = *Chrysso pulchra* (Keyserling)

Achaea signata Keyserling = *Chrysso pulchra* (Keyserling)

Achaea vittata O. P.-Cambridge = *Chrysso vittata* (O. P.-Cambridge)

Unknown species.

Achaea hieroglyphica Mello-Leitão, 1941, Arq. zool. São Paulo, 2: 202. Female holotype from Colatina, Espírito Santo, Brazil, in the Museo Nacional, Rio de Janeiro, was not available for examination. The species was described without illustration of the genitalia.

Unrecognizable species.

Theridion coniferum Blackwall, 1862, Ann. Mag. Nat. Hist., (3) 10:429. Type from Rio de Janeiro, lost.

Achaea quadripunctata Simon, 1895, Ann. Soc. ent. France, 64:145. Male type from Caraça, Minas Gerais, Brazil, lost.

In the keys, references to "Fig." indicate illustrations in this paper, while "1955, fig." and "1959, fig." indicate that the illustration was published in my previous papers on *Achaearanea*.

Key to female *Achaearanea*

1a. Abdomen with two humps (1959, fig. 8), Mexico . . . *hermosillo* Levi

1b. Abdomen without humps or with one hump 2

2a. Abdomen longer than wide or high (1955, fig. 9; Fig. 4) 3

2b. Abdomen usually higher than long or subspherical 5

3a. Spinnerets closer to pedicel than to posterior tip (Fig. 100); southeastern Brazil . . . . . *isaura* sp. n.

3b. Spinnerets closer to posterior tip than to pedicel (Fig. 4) . . . 4

4a. Depression of epigynum with a posterior sclerotized rim (1955, fig. 8); Central to South America . . . . *trapezoidalis* (Taczanowski)

4b. Depression of epigynum with anterior rim only (Fig. 6); Peru . . . . *tingo* sp. n.

5a. Epigynum with two sclerotized disks in one or two lighter areas (1959, figs. 19, 21, 23, 68; Fig. 106) 6

5b. Epigynum otherwise 10
6a. Two sclerotized disks in a median light area (1959, fig. 68); Mexico ..... *nayaritensis* Levi
6b. Each sclerotized disk in its own suboval light area (1959, figs. 19, 21, 23; Fig. 106) 7
7a. Seminal receptacles separated more than their diameter (Fig. 105); Paraguay ..... *rapa* sp. n.
7b. Seminal receptacles almost touching 8
8a. Light areas of epigynum large (1959, fig. 23); Mexico ..... *serax* Levi
8b. Light areas smaller (1959, figs. 19, 21) 9
9a. Total length 2.6-4.7 mm; Mexico, Panama, West Indies ..... *florens* (O. P.-Cambridge)
9b. Total length 1.8-2.6 mm; Texas to Venezuela ..... *florendida* Levi
10a. Epigynum with two dark spots or patches side by side (Figs. 27, 38) 11
10b. Epigynum otherwise 18
11a. Dark spots their diameter or less apart 12
11b. Dark spots one and one-half or more diameters apart 15
12a. Spots their diameter apart, connected anteriorly (Fig. 27); southern Brazil ..... *passiva* (Keyserling)
12b. Spots otherwise 13
13a. Posterior border of epigynum with a lip; spots not circular (1959, fig. 43); Mexico ..... *pura* (O. P.-Cambridge)
13b. Posterior border without lip; spots circular 14
14a. Southeastern Brazil ..... *riocnsis* sp. n.
14b. Guatemala, Venezuela to Peru ..... *taeniata* (Keyserling)
15a. Dark spots separated by a short median scape (1959, fig. 28); Mexico ..... *manzanillo* Levi
15b. No median scape present 16
16a. Venter of abdomen with a median white patch (1955, fig. 59); Arizona ..... *chiricahua* Levi
16b. Venter of abdomen otherwise 17
17a. Eastern United States (1955, figs. 47-49) ..... *rupicola* (Emerton)
17b. Western United States ..... *fresno* Levi
and ..... *canionis* (Chamberlin and Gertsch)
18a. Epigynum with ducts visible as two longitudinal dark stripes, almost parallel (Figs. 78, 80, 82, 85) 19
18b. Epigynum otherwise 20
19a. Epigynum little swollen behind, posterior border straight (Figs. 78, 80, 82); widespread South America ..... *migrans* (Keyserling)
19b. Epigynum swollen, posterior border rounded (Fig. 85); Ecuador ..... *pilaton* sp. n.
20a. Epigynum with a pair of openings, each partially covered medially by a membrane (1959, fig. 55); atria thin-walled and cone-shaped (1959, fig. 54) Mexico, West Indies to Paraguay ..... *nigrovittata* (Keyserling)
20b. Epigynum, genitalia otherwise 21
21a. Epigynum with two transverse raised areas (1959, fig. 62); Central America ..... *oblivia* (O. P.-Cambridge)

21b. Epigynum otherwise 22
22a. Epigynum with large oval transverse opening on a swelling (Fig. 15); Ecuador ..... *milagro* sp. n.
22b. Epigynum otherwise 23
23a. Epigynum with posterior swelling or boss, or if relatively flat, opening far anterior 46
23b. Epigynum without posterior swelling or boss and with openings center or posterior 24
24a. Two openings or depressions separated by septum (Figs. 87, 88); Brazil *bellula* (Keyserling)
24b. Epigynum otherwise 25
25a. Epigynum with a central dark spot (Fig. 94); southern Brazil, Uruguay *pingue* (Keyserling)
25b. Epigynum otherwise 26
26a. Epigynum opening a transverse slit, the posterior rim of an anterior depression (1959, figs. 36, 48; Fig. 69) 27
26b. Epigynum otherwise 29
27a. Ducts visible on each side of depression and separating from each other anteriorly (Fig. 69); Chile ..... *chilensis* sp. n.
27b. Ducts otherwise 28
28a. Ducts looping anterior to seminal receptacles (1959, figs. 46, 47); Panama, West Indies ..... *maricaoensis* (Bryant)
28b. Ducts loop posterior to seminal receptacles (1959, fig. 35); Panama to Paraguay ..... *hirta* (Taczanowski)
29a. Central opening small, diameter less than radius of seminal receptacles 30
29b. Central opening or depression large, diameter more than two-thirds longer than diameter of seminal receptacles 34
30a. Opening more than four diameters from posterior border of epigynum 31
30b. Opening less than two diameters from posterior border 32
31a. Opening with sclerotized rim (Fig. 99); southern Brazil ..... *jequirituba* sp. n.
31b. Opening without rim (1959, fig. 31); Lesser Antilles ..... *trinidensis* Levi
32a. Ducts swollen (Fig. 30); southern Brazil ..... *quadripartita* (Keyserling)
32b. Ducts of even diameter 33
33a. Duct loops some distance from posterior margin (Fig. 22); epigynum lightly sclerotized (Fig. 23); southeastern Brazil ..... *vivida* (Keyserling)
33b. Duct loops almost touching posterior margin (Fig. 24); epigynum heavily sclerotized (Fig. 25); eastern Brazil ..... *barra* sp. n.
34a. Central depression only with anterior border (Fig. 3); ducts coiled (Fig. 2); French Guiana, Peru ..... *pentagona* (Caporiacco)
34b. Epigynum otherwise 35
35a. Depression with anterior median dark marks (Fig. 17); Ecuador, Peru *dromedariforma* (Roewer)
35b. Epigynum otherwise 36

36a. Depression enclosing two dark spots and having narrow sclerotized posterior rim (1959, fig. 33); Panama, Peru, eastern Brazil ... *zonensis* Levi

36b. Epigynum otherwise ... 37

37a. Duct with tight coil on each side of depression (1955, fig. 71); eastern United States to Panama, West Indies ... *porteri* (Banks)

37b. Ducts without tight coil ... 38

38a. Narrow duct with loose coil on each side of depression (Figs. 18, 19); southern Brazil ... *maxima* (Keyserling)

38b. Ducts otherwise ... 39

39a. Depression bordered only on posterior half (Fig. 12) and portion of duct transverse between seminal receptacles and wall of epigynum (Figs. 10, 11); southern Brazil to Paraguay ... *altiventer* (Keyserling)

39b. Depression and ducts otherwise ... 40

40a. Back of atrium and wide ducts heavily sclerotized (1955, fig. 69); cosmopolitan ... *tepidariorum* (C. L. Koch)

40b. Back of depression not heavily sclerotized ... 41

41a. Posterior rim of depression coiled on each side (1955, fig. 77); abdomen with dorsal hump (1955, fig. 78); Florida, Alabama ... *serenoae* (Gertsch and Archer)

41b. Rim of depression otherwise ... 42

42a. A rim posterior of depression (Fig. 8); Utah ... *ambera* sp. n.

42b. Epigynum otherwise ... 43

43a. Depression heart-shaped (1959, fig. 25); Costa Rica *schraderorum* Levi

43b. Epigynum otherwise ... 44

44a. Ducts entering seminal receptacles on sides (1959, figs. 57, 59, 70); ducts often black; Mexico to southeastern Brazil *tesselata* (Keyserling)

44b. Ducts otherwise ... 45

45a. Ducts with a loop (Fig. 20); Chile ... *lota* sp. n.

45b. Ducts straight (Fig. 34); Colombia ... *caliensis* sp. n.

46a. Epigynum with two openings ... 47

46b. Epigynum with one opening ... 54

47a. Opening on each side of swelling (1959, fig. 65); Mexico to Costa Rica *rostrata* (O. P.-Cambridge)

47b. Opening on anterior face of swelling or anterior to swelling ... 48

48a. Openings anterior to swelling (1955, figs. 15, 37) ... 49

48b. Openings on anterior face of swelling (1955, figs. 21, 44; Figs. 51, 97) ... 50

49a. Swelling indistinct (1955, fig. 37); abdomen with dark pigment (1955, fig. 38); Florida, California to Mexico ... *schullei* (Gertsch and Mulaik)

49b. With swelling (1955, fig. 15); abdomen mainly whitish (1955, fig. 18); southeastern U. S. ... *conjuncta* (Gertsch and Mulaik)

50a. Openings more than four diameters apart (1955, fig. 21); posterior of abdomen white with a black patch (1955, fig. 19); eastern U. S. to northeastern Mexico ... *globosa* (Hentz)

50b. Openings about two diameters or less apart ... 51

51a. Median area of swelling light (1959, fig. 15); Jamaica ... *anna* Levi

51b. Epigynum otherwise 52
52a. Openings separated by a narrow septum (1955, figs. 43, 44); Texas, northern Mexico ..... *insulsa* (Gertsch and Mulaik)
52b. Epigynum otherwise 53
53a. Swelling extending posterior (Fig. 97); southeastern Brazil ..... *eramus* sp. n.
53b. Swelling slight, not extending posterior (Fig. 92); Venezuela, Colombia ..... *alacre* (Keyserling)
54a. California; genitalia as in 1955, figures 39, 40 ..... *acoreensis* (Berland)
54b. West Indies, Central or South America 55
55a. Seminal receptacles separated by more than one diameter (1959, fig. 1); opening with sclerotized anterior rim (1959, figs. 2, 3); Cuba ..... *turquino* Levi
55b. Seminal receptacles two-thirds their radius or less apart, opening otherwise; Central and South America 56
56a. Opening almost square, posterior to it a dark shadow (Fig. 56); Peru ..... *leguiai* (Chamberlin)
56b. Epigynum otherwise 57
57a. Ducts elbowed (Fig. 65); Peru ..... *koepckei* sp. n.
57b. Ducts without elbows 58
58a. Abdomen very short (Fig. 59); ducts fine, length equal to larger radius of seminal receptacles (Fig. 57); Venezuela ..... *anastema* sp. n.
58b. Abdomen longer; ducts thicker or shorter 59
59a. Epigynum bulging posterior (Fig. 51), ducts heavily sclerotized, longer than diameter of seminal receptacles (Fig. 50); Peru ..... *kaspi* sp. n.
59b. Epigynum otherwise, ducts much shorter 60
60a. Opening very large, its diameter from posterior rim 61
60b. Opening smaller, one and one-half diameters from posterior rim 62
61a. Atrial wall heavily sclerotized (Fig. 60); Ecuador ..... *banosensis* sp. n.
61b. Atrial wall otherwise (Figs. 70, 71); southeastern Brazil ..... *sicki* sp. n.
62a. Swelling projecting, ventrally (Figs. 53, 54); Peru ..... *gigantea* (Keyserling)
62b. Swelling less distinct 63
63a. Abdomen orange with white lines; genitalia as in Figures 62, 63; southeastern Brazil ..... *cinnabarina* sp. n.
63b. Abdomen colored otherwise 64
64a. Abdomen whitish with well-defined black spots (Fig. 72); genitalia as in Figures 73, 74; southern Brazil ..... *analista* sp. n.
64b. Abdomen with stripes 65
65a. Less than 2 mm total length; Panama ..... *apex* Levi
65b. More than 4 mm total length; Colombia ..... *eaqueza* sp. n.

Key to male *Achaearanea*

1a. Ectal side of cymbium supporting embolus coil (1955, figs. 11-13); South America ..... *trapezoidalis* (Taczanowski)

1b. Cymbium otherwise 2
2a. Embolus or conductor extending distally beyond cymbium 3
2b. Embolus or conductor not extending beyond cymbium 21
3a. Conductor with an ectal spur (1955, fig. 53); California ..... *fresno* Levi
3b. Conductor without spur 4
4a. Embolus width almost half that of tegulum, embolus with a seam (1955, fig. 83); cosmopolitan ..... *tepidariorum* (C. L. Koch)
4b. Embolus otherwise 5
5a. Conductor position transverse to axis of cymbium 6
5b. Conductor position nearly parallel to cymbium axis 7
6a. Conductor with a long ectal extension (1959, fig. 51); Panama ..... *machaera* Levi
6b. Conductor otherwise (1959, figs. 49, 50); Puerto Rico, Panama ..... *maricaoensis* (Bryant)
7a. Embolus with a whip-like distal portion; United States 8
7b. Embolus otherwise; United States to South America 9
8a. Whip portion of embolus equal to cymbium in length (1955, fig. 79); Alabama, Florida ..... *serenoae* (Gertsch and Archer)
8b. Whip portion of embolus longer than cymbium (1955, figs. 80-81); eastern United States to Panama, West Indies ..... *porteri* (Banks)
9a. Embolus and conductor confined to mesal half of tegulum 10
9b. Embolus, conductor otherwise 15
10a. Cymbium with a distal spine (Figs. 39, 40); Arizona ..... *chiricahua* Levi
10b. Cymbium otherwise 11
11a. Embolus bifurcate (Fig. 48); southeastern Brazil ..... *sicki* sp. n.
11b. Embolus otherwise 12
12a. Embolus base near base of tegulum (1959, fig. 44); Mexico ..... *pura* (O. P.-Cambridge)
12b. Embolus base in distal half of tegulum 13
13a. Base of embolus broad and flat (1955, figs. 60-62); Utah, California ..... *canionis* (Chamberlin and Gertsch)
13b. Base of embolus otherwise 14
14a. Abdomen longer than wide, embolus cone-shaped (Fig. 113); southern Brazil ..... *isana* sp. n.
14b. Abdomen otherwise; palpus otherwise (Fig. 112); Ecuador *orana* sp. n.
15a. Embolus a broad sclerite (1959, fig. 29); Trinidad ..... *trinidensis* Levi
15b. Embolus otherwise 16
16a. Embolus seemingly U-shaped, or embolus on ectal side of tegulum (1959, figs. 52, 56; Figs. 109, 110) 17
16b. Embolus straight or on mesal side of tegulum 19
17a. Embolus on mesal side of tegulum (1959, fig. 52); Cuba, Panama ..... *terex* Levi
17b. Embolus reaching ectal side of tegulum 18
18a. Embolus clearly U-shaped (1959, fig. 56; Fig. 110) Mexico, West Indies to Paraguay ..... *nigrovittata* (Keyserling)
18b. Embolus otherwise (Fig. 109); Costa Rica ..... *mieratula* (Banks)

19a. Duct with loop in tegulum (Fig. 33); eastern and southern Brazil ... *quadripartita* (Keyserling)

19b. Duct otherwise ... 20

20a. Embolus with a neck and wide distal portion as in Figure 111; French Guiana ... *pussilana* (Roewer)

20b. Embolus otherwise (Fig. 108); Ecuador ... *milagro* sp. n.

21a. Embolus U-shaped, cymbium rounded above as in Figure 103; Paraguay *rapa* sp. n.

21b. Embolus otherwise ... 22

22a. Embolus a broad cone or spine on tegulum, not a separate sclerite ... 23

22b. Embolus not cone-shaped and always a separate sclerite ... 29

23a. Embolus with two tips ... 24

23b. Embolus with one tip ... 25

24a. Cymbium with stout tip (1959, fig. 17); Texas to Venezuela ... *florendida* Levi

24b. Cymbium with slender tip (1959, fig. 16); Cuba, Mexico to Panama ... *florens* (O. P.-Cambridge)

25a. Cymbium with tip hooked; duct in tegulum with elbow below embolus (1959, fig. 12); Panama ... *apex* Levi

25b. Cymbium, duct otherwise ... 26

26a. In ventral view, duct below embolus describing half circle ... 27

26b. In ventral view, duct below embolus going toward base on ectal side with slight undulation before looping back toward distal and dorsal side of tegulum ... 28

27a. Abdomen with two humps; distal end of cymbium broad (1959, figs. 6, 7); Mexico ... *hermosillo* Levi

27b. Abdomen without humps; distal end of cymbium narrow (1955, figs. 16, 17); southeastern United States ... *conjuncta* (Gertsch and Mulaik)

28a. Distal end of cymbium broad (1959, fig. 13); Jamaica ... *anna* Levi

28b. Distal end of cymbium narrow (1955, figs. 22-25); eastern United States ... *globosa* (Hentz)

29a. Duct with S-shaped loop in tegulum; Central, South America ... 30

29b. Ducts not looping in an S or, if S-shaped, found in North America ... 31

30a. Embolus reaching almost to base of tegulum (1959, fig. 37); Panama to Paraguay ... *hirta* (Taczanowski)

30b. Embolus shorter (Fig. 41); Minas Gerais ... *diamantina* sp. n.

31a. In ventral view two duct loops in tegulum as in Figure 45; southern Brazil, Paraguay ... *altiventer* (Keyserling)

31b. Duct loops otherwise ... 32

32a. Duct with a long distally directed loop (Figs. 42, 46) ... 33

32b. No loop present or only a slight wave in course of duct ... 34

33a. Distal portion of embolus broad (Fig. 42); eastern Brazil *parana* sp. n.

33b. Distal portion of embolus narrow (Fig. 46); southeastern Brazil *cinnabarina* sp. n.

34a. Embolus a small transparent squarish sclerite on meso-ventral face of bulb (1955, figs. 33, 35); Florida, California, Mexico ... *schullei* (Gertsch and Mulaik)

34b. Embolus shaped otherwise and extending distally beyond tegulum . . 35
35a. Embolus with a spur (Fig. 29); Venezuela . . . . . *tovarensis* sp. n.
35b. Embolus otherwise 36
36a. Embolus with an almost straight (in ventral view) filiform distal portion, longer than tegulum diameter (1959, fig. 26); Panama . . . . . *schneirlai* Levi
36b. Embolus otherwise 37
37a. Distal knob of cymbium wider than immediate portion below 38
37b. Distal tip of cymbium without neck 39
38a. Length of cymbium portion distal to alveolus equal to tegulum diameter (Fig. 44); Peru . . . . . *uviana* sp. n.
38b. Cymbium extending only slightly beyond tegulum (1959, fig. 34); Panama . . . . . *zonensis* Levi
39a. Cymbium tip with a thumb on ectal side (1959, fig. 41); Guatemala to Venezuela . . . . . *taeniata* (Keyserling)
39b. Cymbium tip otherwise 40
40a. Cymbium tip with three lobes (Fig. 43); Guiana . . . . . *inops* sp. n.
40b. Cymbium tip otherwise 41
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47b. Palpus as in Figure 49; southeastern Brazil . . . . . *pallipera* nom. nov.

Achaearanea trapezoidalis (Taczanowski)

Map 2

Argyrodes trapezoidalis Taczanowski, 1873, Horae Soc. Ent. Rossicae, 9: 115, pl. 5, fig. 10. Female and male syntypes from Uassa [Rio Uaçá, Amapa, Brazil] and Cayenne, French Guiana, in the Polish Academy of Sciences, Warsaw.

Achaea insignis O. P.-Cambridge, 1882, Proc. Zool. Soc. London, p. 428, pl. 30, fig. 5, ♂. Male holotype from the Amazon in the Hope Department of Entomology, Oxford.

Thwaitesia diversa O. P.-Cambridge, 1882, *ibid.*, p. 432, pl. 31, fig. 8, ♀. Female holotype from the Amazon in the Hope Department of Entomology, Oxford.

Achaearanea trapezoidalis, — Levi, 1955, Amer. Mus. Novitates, no. 1718: 9, figs. 7-13, ♀, ♂; 1959, Bull. Mus. Comp. Zool. 121: 76.

Distribution. Panama to Paraguay (Map 2).

Additional Records. Trinidad: Balandra Bay (Reynolds). *Venezuela. Delta Amacuro:* Río Orinoco delta, Jan.-Feb. 1935 (N. Weber). *Peru. San Martín:* Moyobamba, 20 Dec. 1946 (J. C. Pallister, AMNH). *Huánuco:* Monzón Valley, Tingo María, Nov. 1954 (E. I. Schlinger, E. S. Ross, CAS). *Brazil. Pará:* Belém, Feb. 1959 (A. M. Nadler, AMNH), doubtful determination. *Paraguay. Alto Paraná:* Taquararapa (AMNH).

Achaearanea pentagona (Caporiacco), new combination

Figures 1-3

Chrysso pentagona Caporiacco, 1954, Comm. Pontificia Acad. Sci., 16: 75, fig. 12, ♀. Female holotype from Goudronville, French Guiana, in the Muséum National d'Histoire Naturelle, Paris, examined.

This species is very close to *A. trapezoidalis*. The abdomen of the type, from which Figure 1 was made, is shrunken. In other specimens the middle constriction of the abdomen is less pronounced or absent. The species differs by lacking the posterior lip of the epigynum depression (Fig. 3) and by the position of the coil (Fig. 2). The abdomen is shorter than that of *A. trapezoidalis* and *A. tingo*. The illustrations were made from the holotype.

Records. Peru. Huánuco: Monzón Valley, Tingo María, Oct., Nov., 1954 (E. I. Schlinger, E. S. Ross, CAS); Santa Teresa, Río Huallaga, 600 m, Aug. 1954 (F. Woytkowski); Cucharas, Huallaga Valley, Feb., April 1954 (F. Woytkowski).

Achaearanea tingo sp. n.

Figures 4-6

Type. Female holotype from Tingo María, Huánuco, Peru, 19-25 May 1947 (J. C. Pallister), in the American Museum of Natural History. The specific name is a noun in apposition after the type locality.

Description. The whole spider is light orange in color except for a black spot in center of sternum. Anterior median eyes slightly larger than others, two-thirds diameter apart, their radius from laterals. Posterior median eyes a little more than their diameter apart, their diameter from laterals. Abdomen longer than high (Fig. 4). Total length 2.3 mm. Carapace 1.14 mm long, 0.91 mm wide. First femur, 2.20 mm; patella and tibia, 2.16 mm; metatarsus, 1.82 mm; tarsus, 0.78 mm. Second patella and tibia, 1.22 mm; third, 0.80 mm; fourth, 1.49 mm.

Diagnosis. Like *A. pentagona, A. tingo* lacks the posterior lip of the depression in the epigynum (Fig. 6) which is present in *A. trapezoidalis.* The depression is smaller than in the preceding two species and the duct coil relatively larger (Fig. 5).

Achaearanea globosa (Hentz)

Map 1

Theridion globosum Hentz, 1850, Jour. Boston Soc. Nat. Hist., 6: 279, pl. 9, fig. 23, ♀. Types from Alabama lost.

Achaearanea globosa, — Levi, 1955, Amer. Mus. Novitates, no. 1718: 9, figs. 19-25, ♀, ♂.

Distribution. Eastern United States to Veracruz, Mexico (Map 1).

Additional records. Minnesota. Winona Co.: Whitewater State Park (H. Levi). *Texas.* San Patricio Co.: SW of Mathis (R. O. Albert).

Achaearanea schullei (Gertsch and Mulaik)

Map 1

Theridion schullei Gertsch and Mulaik, 1936, Amer. Mus. Novitates, no. 863: 15, fig. 22, ♀. Female type from Edinburgh, Texas, in the American Museum of Natural History.

Achaearanea schullei, — Levi, 1955, *ibid.,* no. 1718: 17, figs. 32-38, ♀, ♂; 1959, Bull. Mus. Comp. Zool. 121: 61.

Distribution. Florida, Texas, Mexico (Map 1).

Additional records. Texas. Dallas Co.: Dallas, woods at California Crossing in log, 26 May 1940, ♀ (H. Knutsen). *Arizona.* Pima Co.: Tucson, 730 m, on outside of building, 6 Sept. 1959, ♀ (J. Beatty); Twin Buttes Mine, 1000 m, in web over crevice in roof of tunnel, 30 July 1960, ♂ (J. Beatty).

Achaearanea ambera sp. n.

Figures 7-8

Type. Female holotype, from Mill Creek Canyon, Salt Lake City, Salt Lake Co., Utah (R. V. Chamberlin), in the American Museum of Natural History. The specific name is an arbitrary combination of letters.

Description. Carapace brownish. Sternum brown. Legs yellowish. Abdomen with a dorsal white stripe from hump to anal tubercle. The stripe is crossed by a wide line, and has light patches on each side. Eyes subequal in size. Anterior median eyes one diameter apart, almost touching laterals. Posterior median eyes one diameter apart, a little more than one diameter from laterals. Abdomen with a hump. Total length 2.0 mm. Carapace 0.78 mm long, 0.78 mm wide. First femur, 1.30 mm; patella and tibia, 1.32 mm; metatarsus, 1.00 mm; tarsus, 0.52 mm. Fourth patella and tibia, 0.60 mm.

Diagnosis. Unlike other *Achaearanea* species, *A. ambera* has the epigynum with a lip parallel to the posterior border (Fig. 8).

Achaearanea altiventer (Keyserling), new combination

Figures 9-12, 45; Map 2

Achaea altiventer Keyserling, 1884, Die Spinnen Amerikas, Theridiidae, 2(1): 108, pl. 5, fig. 70, ♀. Juvenile female holotype from "Süd. Amerika," in the Hope Department of Entomology, Oxford University, examined.

Theridion altiventer, — Simon, 1894, Histoire Naturelle des Araignées, 1: 535.

Note. The type specimen is a juvenile female just before the final molt. Luckily the internal ducts are sufficiently sclerotized to leave no doubt about its placement, as the characteristic transverse portions of the ducts can be seen.

Description. Carapace yellow with a median dusky area. Sternum dusky. Legs yellow with dusky bands. Abdomen with a black dorsal, longitudinal, median band that is bordered by white; several dark and light stripes on side (Fig. 9); venter with a black mark anterior to spinnerets and a black line connecting this mark with genital groove; on each side of dark line is a white spot. Eyes subequal in size, anterior median eyes a little more than one diameter apart, their radius from laterals. Posterior eyes their diameter apart. Chelicerae without teeth. Abdomen with a hump. Total length of female from Paraguay 5.6 mm. Carapace 1.6 mm long, 1.3 mm wide. First femur, 4.1

mm; patella and tibia, 3.6 mm; metatarsus, 3.5 mm; tarsus, 1.0 mm. Second patella and tibia, 2.0 mm; third, 1.0 mm; fourth, 2.3 mm. Total length of male 2.8 mm. Carapace 1.4 mm long, 1.2 mm wide. First femur, 2.2 mm; patella and tibia, 2.3 mm; metatarsus, 2.2 mm; tarsus, 0.8 mm. Second patella and tibia, 1.3 mm; third, 0.9 mm; fourth, 1.3 mm.

Distribution. Southern and southeastern Brazil (Map 2).

Records. Brazil. Pernambuco: Recife (SMF). *Guanabara:* Teresópolis, March 1946, 900-1000 m, ♀ (H. Sick, AMNH). *São Paulo:* Pinhal, Dec. 1948 (A. Maller, AMNH); Jequirituba, 750 m, Cidade de São Paulo, Dec. 1945, ♀, ♂ (H. Sick, AMNH). *Santa Catarina:* Nova Teutonia, lat 27°11′S, long 52°23′W (F. Plaumann, SMF). *Paraguay.* 1891, 1893, 3 ♀ (Dr. Bohls, BMNH); ♂ (Germain, MNHN).

Achaearanea maxima (Keyserling), new combination

Figures 18-19

Achaea maxima Keyserling, 1891, Die Spinnen Amerikas, Brasilianische Spinnen, 3: 198, pl. 7, fig. 142, ♀. Female holotype from Rio Grande [do Sul], Brazil, in the British Museum, examined.

Theridion maximum, — Simon, 1894, Histoire Naturelle des Araignées, 1: 535.

The illustrations were made from the type specimens.

Achaearanea dromedariforma (Roewer), new combination

Figures 16-17

Achaea dromedaria Keyserling, 1884, Die Spinnen Amerikas, Theridiidae, 2(1): 109, pl. 5, fig. 71, ♀. Female holotype from Lechugal, [Tumbes], Peru, in the Polish Academy of Sciences, Warsaw, examined. Not *Theridion dromedarium* Simon, 1880, which may also be an *Achaearanea.*

Theridion dromedarius, — Simon, 1894, Histoire Naturelle des Araignées, 1: 535. Not *Theridion dromedarium* Simon, 1880.

Theridion dromedariforme Roewer, 1942, Katalog der Araneae, 1: 491. New name for *Theridion dromedaria* (Keyserling), thought to be preoccupied.

This small light-colored species usually has a hump on the abdomen. Specimens from Quebrada Mogollón lack the hump. The epigynum has a large, shallow, oval depression with two anterior spots (Fig. 17). The illustrations were made from the holotype.

Records. Ecuador. Guayas: Colonche, 1941 (R. W. Landes). *Peru. Piura:* Quebrada Mogollón, 18 June 1939 (H. E., D. L. Frizzell).

Achaearanea lota sp. n.

Figures 20-21

Type. Female holotype from Lota, Concepción, Chile, in the Muséum National d'Histoire Naturelle, Paris (no. 10355). The specific name is a noun in apposition after the type locality.

Description. Carapace, sternum, legs brown. Dorsum of abdomen with broad black stripes going down sides and small white pigment spots like *A. koepckei* (Fig. 64). Venter with two black spots behind epigastric groove and two black spots anterior to spinnerets; there is a semicircular black mark on each side of pedicel. Anterior median eyes slightly larger than others, two-thirds their diameter apart, less than one-quarter from laterals. Posterior eyes less than their diameter apart. Total length 4.0 mm. Carapace 1.6 mm long, 1.4 mm wide. First femur, 2.9 mm; patella and tibia, 3.0 mm; metatarsus, 2.2 mm; tarsus, 0.8 mm. Second patella and tibia, 2.1 mm; third, 1.4 mm; fourth, 2.2 mm.

Diagnosis. The depression of the epigynum (Fig. 21) is of different shape than that of *A. chilensis* and the ducts are shorter (Fig. 20).

Records. Four paratypes collected with holotype.

Achaearanea vivida (Keyserling), new combination

Figures 22-23

Theridium vividum Keyserling, 1891, Die Spinnen Amerikas, Brasilianische Spinnen, 3: 192, pl. 7, fig. 139, ♀. Female holotype from Espírito Santo on the Río Minas [?], Brazil, in the British Museum, examined.

This species has a pair of ventral white spots, side by side on the abdomen. The illustrations were prepared from the holotype.

Achaearanea barra sp. n.

Figures 24-25

Type. Female holotype from San Antonio da Barra [Condeúba, Bahia] Brazil (E. Gounelle), in the Muséum National d'Histoire Naturelle, Paris (no. 11520). The specific name is a noun in apposition after the type locality.

Description. Carapace orange-brown, black in head region. Sternum orange. Legs yellowish white with faint indications of wide bands. Abdomen black, dorsum with a light median longitudinal line, wide anteriorly and narrow above spinnerets.

Descending on each side a short anterior light line and a longer line posteriorly. Venter behind the epigynum with a white patch, longer than wide. Anterior median eyes slightly larger than others, their radius apart, their radius from laterals. Posterior median eyes three-quarters their diameter apart, a little more than their diameter from laterals. Chelicerae with one tooth on anterior margin. Abdomen higher than long without tubercle. Total length 2.2 mm. Carapace 0.96 mm long, 0.85 mm wide. First femur, 1.17 mm; patella and tibia, 1.20 mm; metatarsus, 0.81 mm; tarsus, 0.58 mm. Second patella and tibia, 1.0 mm; third, 0.75 mm; fourth, 1.09 mm.

Diagnosis. The winding internal ducts separate this species from *A. vivida* (Keyserling) and most other *Achaearanea*. The ducts (Fig. 24) are weakly sclerotized.

Achaearanea passiva (Keyserling), new combination

Figures 26-28

Theridium passivum Keyserling, 1891, Die Spinnen Amerikas, Brasilianische Spinnen, 3: 195, pl. 7, fig. 141, ♀. Female holotype from Fazenda Calvario, Est. Rio de Janeiro [Guanabara], Brazil, in the British Museum, examined.

Note. Chamberlin and Ivie (1934, Bull. Univ. Utah, biol. ser., 2(4): 11) placed this species in *Tidarren*. This apparently was done without examining specimens.

Description. Carapace of male yellow with a gray median longitudinal band enclosing head region in front, narrow behind and bordered with gray. Sternum yellow with a dark spot opposite each coxa. Legs yellow. Abdomen of male with a pair of zig-zag lines on dorsum, a white line above spinnerets, and irregular gray marks; venter with a pair of white spots side by side on a dark background. Female quite variable, but less distinctly marked, usually with area posterior to spinnerets gray. Anterior median eyes slightly larger than others in male, subequal in female; two-thirds their diameter apart, almost touching laterals. Posterior median eyes one diameter apart, two-thirds diameter from laterals in male; all posterior eyes two-thirds diameter apart in female. Total length of male 2.2 mm. Carapace 0.92 mm long, 0.84 mm wide. First femur, 1.98 mm; patella and tibia, 1.98 mm; metatarsus, 2.08 mm; tarsus, 0.81 mm. Second patella and tibia, 1.20 mm; third, 0.75 mm; fourth, 1.17 mm.

Figures 26, 27 were prepared from the holotype.

Diagnosis. The palpal cymbium of this species has two prongs at its tip (Fig. 28), the duct is simple, and the embolus squarish. The epigynum has an indistinct dark area anterior to an indistinct light depression (Fig. 27).

Records. Brazil. Guanabara: Teresópolis, Nov. 1945, March 1946 (H. Sick, AMNH); Petrópolis, Nov. 1945 (H. Sick, AMNH). *São Paulo:* Ribeirão Pires, Dec. 1945 (H. Sick, AMNH); Jequirituba, Cidade São Paulo, Dec. 1945 (H. Sick, AMNH). *Santa Catarina:* Nova Teutonia, lat 27°11′S, long 52°23′W (F. Plaumann, SMF).

Achaearanea quadripartita (Keyserling), new combination

Figures 30-33

Theridium quadripartitum Keyserling, 1891, Die Spinnen Amerikas, Brasilianische Spinnen, 3: 182, pl. 6, fig. 127. Female, male syntypes from Botucatú, São Paulo, Brazil, in the British Museum, examined.

Description. Specimen from Minas Gerais. Carapace orange; black between eyes. Sternum, legs, orange. Abdomen orange-white, darker orange on venter; dorsum with four large black patches separated by a white line on each side and a line above spinnerets (Fig. 32). Anterior median eyes slightly smaller than others, one and one-half diameters apart, one-quarter diameter from laterals. Posterior median eyes three-quarters diameter apart, one diameter from laterals. Chelicerae with one tooth on anterior margin. Total length of female 2.0 mm. Carapace 0.9 mm long, 0.8 mm wide. First femur, 1.0 mm; patella and tibia, 1.0 mm; metatarsus, 0.6 mm; tarsus, 0.5 mm. Second patella and tibia, 0.9 mm; third, 0.7 mm; fourth, 1.0 mm.

The connecting ducts are widened in one place (Fig. 30); the palpal duct is fine and looping. The illustrations were prepared from the syntypes.

Records. Brazil. Minas Gerais: Caraça, ♀ (E. Gounelle, MNHN). *Santa Catarina:* Nova Teutonia, lat 27°11′S, long 52°23′W, ♀, ♂ (F. Plaumann, SMF).

Achaearanea caliensis sp. n.

Figures 34-35

Type. Female holotype from 21 km west of Cali, Valle, Colombia, 20 March 1955 (E. I. Schlinger, E. S. Ross), in the California Academy of Sciences. The species is named after the type locality.

Description. Carapace dark gray-brown. Sternum red-brown. Legs yellow-white with black patches on venter and black rings on distal ends of segments. Abdomen with typical irregular patches and jagged white lines down sides; venter dark with a pair of discrete white spots side by side. Anterior median eyes slightly larger than others, their diameter apart, one-quarter diameter from laterals. Posterior median eyes their diameter apart, almost one diameter from laterals. Abdomen higher than long without tubercle. Total length 3.0 mm. Carapace 1.2 mm long, 1.0 mm wide. First femur, 1.9 mm; patella and tibia, 1.8 mm; metatarsus, 1.5 mm; tarsus, 0.7 mm. Second patella and tibia, 1.1 mm; third, 0.9 mm; fourth, 1.4 mm.

Diagnosis. Two openings are in a small depression near the posterior rim of the epigynum depression (Fig. 35). The connecting ducts are short (Fig. 34). The position of the openings in the depression separate this species from other *Achaearanea.* The coloration and larger size separate it from *A. zonensis.*

Record. Ecuador. Pichincha: 10 km W of Santo Domingo de los Colorados, 23 Feb. 1955, ♀ (E. I. Schlinger, E. S. Ross, CAS).

Achaearanea zonensis Levi

Map 2

Achaearanea zonensis Levi, 1959, Bull. Mus. Comp. Zool., 121: 69, figs. 32-34, ♀, ♂. Male holotype from Panama Canal Zone in the Museum of Comparative Zoology.

Distribution. Panama, Peru, Brazil (Map 2).

Additional Records. British Guiana. Upper Essequibo River, (W. G. Hassler, AMNH). *Ecuador. Guayas:* Milagro (H. E., D. L. Frizzell); Julio Moreno (H. E., D. L. Frizzell). *El Oro:* 20 km SE of Machala (E. L. Moore). *Peru. Piura:* Cerro Negro (H. E., D. L. Frizzell). *Brazil. Pernambuco:* Recife (SMF). *Bahia:* Salvador (E. Goeldi, MNHN).

Achaearanea rioensis sp. n.

Figures 36-38

Type. Male holotype from Teresópolis, 900-1000 m elev., Est. Guanabara, Brazil, March 1949 (H. Sick), in the American Museum of Natural History. The specific name is after the type locality.

Description. Carapace grayish brown. Sternum yellow with dusky margin. Legs brown. Abdomen with white pigment spots

on dorsum. Venter black with a white spot on each side. Abdomen of female with posterior portion white, anterior and venter dark. Eyes subequal in size. Anterior median eyes two-thirds diameter apart, almost touching laterals. Posterior median eyes of male two-thirds diameter apart, one diameter from laterals. Female with posterior eyes one diameter apart, two-thirds diameter from laterals. Total length of female 2.7 mm. Carapace 1.10 mm long, 0.98 mm wide. First femur, 1.62 mm; patella and tibia, 1.69 mm; metatarsus, 1.38 mm; tarsus, 0.65 mm. Second patella and tibia, 1.17 mm; third, 0.85 mm; fourth, 1.40 mm. Total length of male 2.00 mm. Carapace 0.91 mm long, 0.77 mm wide. First femur, 1.62 mm; patella and tibia, 1.56 mm; metatarsus, 1.30 mm; tarsus, 0.62 mm. Second patella and tibia, 1.10 mm; third, 0.71 mm; fourth, 0.96 mm.

Diagnosis. The cymbium and embolus (Fig. 36) differ in shape from those of *A. taeniata.* The female is smaller than *A. taeniata* and has a similar epigynum (Fig. 38). The possibility that the female and male do not belong together, and that the female is actually *A. taeniata,* should be considered; however, no other specimens of the latter species have been found from southeastern Brazil.

Records. Brazil. Guanabara: Teresópolis, 7-9 Nov., 1945, ♀; March 1949, 2 ♀ paratypes (H. Sick, AMNH); Sumaré, Cidade Rio de Janeiro, Feb. 1946, ♀ (H. Sick, AMNH).

Achaearanea taeniata (Keyserling)

Map 2

Theridium taeniatum Keyserling, 1884, Die Spinnen Amerikas, Theridiidae, 2(1): 12, pl. 1, fig. 2, ♀, ♂. Female, male syntypes from Caracas, Venezuela, in the Institut Royal des Sciences Naturelles, Brussels, examined.

Theridion salvadorense Kraus 1955, Abhandl. senckenbergischen naturf. Gesell., no. 493: 17, figs. 34-36, ♀. Female type from El Salvador in the Senckenberg Museum. NEW SYNONYMY.

Achaearanea taeniata, — Levi, 1959, Bull. Mus. Comp. Zool., 121: 72, figs. 39-41, ♀, ♂.

The distance between each other and the size of the two black spots in the epigynum are variable. A paratype of *Theridion salvadorense* examined was the only specimen whose posterior epigynal margin was sclerotized, and the two spots were relatively small. Otherwise, it does not seem to differ.

Distribution. Guatemala, Trinidad, Venezuela to Peru (Map 2).

Additional records. Costa Rica: 11 km W of Turrialba, "from walls of canyon" (Hamilton). *Venezuela. Aragua:* Maracay, 1935, 1936 (P. C. Vogl, ZSM). *Dist. Federal:* La Guaira, 1888 (E. Simon); Caracas, 1888 (E. Simon, MNHN). *Colombia. Cundin Amarca:* 23 km SE of Cáqueza, March 1955, ♂ (E. I. Schlinger, E. S. Ross, CAS). *Tolima:* Ibague, March 1955, ♀ (E. I. Schlinger, E. S. Ross, CAS). *Peru. Junín:* Uteuyacu, March 1948, ♂ (F. Woytkowski, AMNH).

Achaearanea tovarensis sp. n.

Figure 29

Type. Male holotype from Tovar, Aragua, Venezuela, January, February 1888 (E. Simon), in the Muséum National d'Histoire Naturelle, Paris (no. 10986). The species is named after the type locality.

Description. Carapace, sternum, legs reddish brown. The anterior half of abdomen black; posterior of dorsum with three black spots and small white pigment spots that invade the anterior black area in two places. Venter all black with two small white spots side by side. Anterior median eyes slightly larger than others, their radius apart, one-quarter diameter from laterals. Posterior median eyes two-thirds diameter apart, one diameter from laterals. Chelicerae with one blunt tooth on anterior margin. Total length 2.5 mm. Carapace 1.2 mm long, 1.0 mm wide. First femur, 1.9 mm; patella and tibia, 1.9 mm; metatarsus, 1.4 mm; tarsus, 0.7 mm. Second patella and tibia, 1.3 mm; third, 0.9 mm; fourth, 1.3 mm.

Diagnosis. This species differs from *A. taeniata* and other *Achaearanea* by having a thorn on the side of the embolus (Fig. 29).

Achaearanea diamantina sp. n.

Figure 41

Type. Male holotype from Minas de Serrinha, Diamantina, Minas Gerais, Brazil, Feb.-March 1945 (E. Cohn), in the American Museum of Natural History. The species is named after the type locality; the specific name is a noun in apposition.

Description. Carapace, sternum, legs, yellowish. Dorsum of abdomen covered with a black patch, surrounded by white pigment spots. Venter colorless yellowish white. Eyes subequal in size. Anterior median eyes one diameter apart, almost touching

laterals. Posterior median eyes less than one diameter apart, one diameter from laterals. Total length 1.7 mm. Carapace 1.00 mm long, 0.84 mm wide. First femur, 1.98 mm; patella and tibia, 2.00 mm; metatarsus, 2.01 mm; tarsus, 0.65 mm. Second patella and tibia, 1.06 mm; third, 0.68 mm; fourth, 1.05 mm.

Diagnosis. The shape of the cymbium and the position of the S-shaped duct in the palpus (Fig. 41) separate this species from *A. hirta.*

Achaearanea hirta (Taczanowski)

Map 2

Argyrodes hirtus Taczanowski, 1873, Horae Soc. Ent. Rossicae, 9: 119. Female syntypes from Cayenne, French Guiana, in the Polish Academy of Sciences, Warsaw, examined.

Achaea undata Keyserling, 1884, Die Spinnen Amerikas, Theridiidae, 2(1): 105, pl. 5, fig. 68, ♀, ♂. Female, male syntypes from Amazonas, Brazil, in the Hope Department of Entomology, Oxford, examined.

Achaea guadalupensis Keyserling 1884, *op. cit.*, p. 110, pl. 5, fig. 72, ♀. Female type from Guadalupa [Guadalupe, Libertad], Peru, in the Polish Academy of Sciences, Warsaw, examined.

Achaea ignota Keyserling, 1884, *op. cit.*, p. 112, pl. 5, fig. 73, ♀. Female syntype from Minas Gerais, [Brazil], in the Hope Department of Entomology, Oxford, examined.

Theridium bentificum Keyserling, 1891, *op. cit.*, Brasilianische Spinnen, 3: 184, pl. 6, fig. 129, ♂. Male holotype from Rio Grande do Sul, Brazil, in the British Museum, examined.

Chrysso maronica Caporiacco, 1954, Comm. Pontifica Acad. Sci., 16: 74, fig. 11, ♀. Female type from S. Jean du Maroni, French Guiana, in the Muséum National d'Histoire Naturelle, Paris, examined.

Achaearanea hirta, — Levi, 1959, Bull. Mus. Comp. Zool., 121: 70, figs. 35-38, ♀, ♂; map 1.

The abdomens of specimens from one collection from near Caraça, Minas Gerais, are variable. Some species have it wider than long, others longer than wide.

Distribution. Central America to southern Brazil (Map 2).

Additional records. Venezuela. Dist. Fed: Hacienda Corosal (E. Simon, MNHN); Caracas (E. Simon, MNHN); La Guaira (E. Simon, MNHN). *Aragua:* Maracay (SMF). *Carabobo:* San Estebán (E. Simon, MNHN). *British Guiana.* Rupununi River (W. G. Hassler, AMNH); Kartabo, Bartica Distr. (W. Beebe, AMNH); Georgetown (A. M. Nadler, AMNH). *French Guiana.* Cayenne (A. M. Nadler, AMNH). *Ecuador. Guayas:* Milagro (H. E., D. L. Frizzell); W. of Guayaquil (R. V. Landes); Guayaquil (Carvalho); Colonche (R. V. Landes). *Peru. Piura:*

Sechura (D. L. Frizzell); Quebrada Mogollón (H. S. M.); 19 km N of Máncora (H. E., D. L. Frizzell). *Junín:* La Merced (A. M. Nadler, AMNH). *Brazil. Pernambuco:* Recife (SMF: A. M. Nadler, AMNH). *Goyás.* (MNHN). *Bahia.* Condeúba, "S. Ant. da Barra" (MNHN); Salvador (A. M. Nadler, AMNH; E. Göldi, MNHN). *Minas Gerais:* Minas Serinha, Diamantina (E. Cohn, AMNH); Rio Tijuca near Caraça (Gounelle, MNHN). *Espírito Santo:* Santa Teresa (A. M. Nadler, AMNH). *Guanabara:* Teresópolis, 900-1000 m (H. Sick, AMNH); Nicterói (Cornell Univ. Exped.); Rio de Janeiro (A. M. Nadler, AMNH). *São Paulo:* São Paulo (Hammad; A. M. Nadler, AMNH). *Santa Catarina:* Nova Teutonia, lat 27°11′S, long 52°23′W (F. Plaumann, SMF). *Paraguay.* (Dr. Bohls, BMNH).

Achaearanea chiricahua Levi

Figures 39-40

Achaearanea chiricahua Levi, 1955, Amer. Mus. Novitates, no. 1718: 26, figs. 57-59, ♀. Female holotype from Rustler Camp, Chiricahua Mountains, Cochise Co., Arizona, in the American Museum of Natural History.

Description. Male. Carapace dusky yellowish, sternum brown, legs yellowish with indistinct bands. Dorsum of abdomen with indistinct white and gray markings. Venter black with a large white patch between epigastric groove and spinnerets. Eyes subequal in size. Anterior medians two-thirds diameter apart, less than one-quarter diameter from laterals. Posterior eyes two-thirds diameter apart. Total length 2.4 mm. Carapace 1.1 mm long, 0.9 mm wide. First femur, 2.5 mm; patella and tibia, 2.3 mm; metatarsus, 1.9 mm; tarsus, 0.8 mm. Second patella and tibia, 1.7 mm; third, 1.1 mm; fourth, 1.4 mm.

The white ventral spot indicates that the specimen is the previously unknown male of *A. chiricahua.*

Record. Arizona. Pima Co.: Rose Canyon access road, just off Mt. Lemmon Rd., 2200 m, Santa Catalina Mtns., under rock in open area, yellow pine, oak, 17 June 1961 (J. Beatty).

Achaearanea parana sp. n.

Figure 42

Type. Male holotype from Taguararapa, Alto-Parana, Paraguay, 1908, in the American Museum of Natural History. The specific name is a noun in apposition after the province of the type locality.

Description. Carapace grayish brown. Sternum reddish brown. Legs lighter yellow-brown. Abdomen with typical white and black streaks like many species of *Achaearanea*. Venter with a pair of white spots side by side on black background. Eyes subequal in size. Anterior median eyes one diameter apart, almost touching laterals. Posterior eyes a little less than their diameter apart. Total length 2.3 mm. Carapace 1.04 mm long, 0.92 mm wide. First femur, 1.82 mm; patella and tibia, 1.82 mm; metatarsus, 1.62 mm; tarsus, 0.62 mm. Second patella and tibia, 1.14 mm, third, 0.67 mm; fourth, 1.08 mm.

Diagnosis. This species can be separated from *A. cinnabarina* by the coloration and different shape of embolus and the conductor (Fig. 42).

Achaearanea cinnabarina sp. n.

Figures 46, 62-63

Type. Male holotype from Teresópolis, Est. Guanabara, Brazil, 6 March 1946 (H. Sick), in the American Museum of Natural History. The specific name refers to the orange color of the species.

Description. Carapace and sternum orange. Legs yellowish gray. Abdomen orange in male, that of female with a white line running from center of dorsum toward venter and posterior on each side; darker behind white line; a white line above spinnerets. Anterior median eyes of male slightly smaller than others, one and one-quarter diameters apart, their radius from laterals. Posterior eyes a little less than their diameter apart. Eyes of female subequal in size. Anterior median eyes a little less than their diameter apart, their radius from laterals. Posterior eyes their diameter apart. Total length of female 4.7 mm. Carapace 1.9 mm long, 1.5 mm wide. First femur, 3.6 mm; patella and tibia, 3.6 mm; metatarsus, 3.5 mm; tarsus, 1.1 mm. Second patella and tibia, 2.2 mm; third, 1.4 mm; fourth, 2.6 mm. Total length of male 2.2 mm. Carapace 0.99 mm long, 0.85 mm wide. First femur, 1.82 mm; patella and tibia, 1.75 mm; metatarsus, 1.53 mm; tarsus, 0.69 mm. Second patella and tibia, 0.94 mm; third, 0.65 mm; fourth, 0.98 mm.

Diagnosis. In color, *A. cinnabarina* is unlike other *Achaearanea*. The different shape of embolus and conductor (Fig. 46) separate this species from *A. parana*. The epigynum has only a slight swelling (Fig. 63). The short connecting ducts separate it from *A. koepckei*.

Records. Brazil. Pernambuco: Recife (SMF). *Guanabara:* Teresópolis, 7-9 Nov. 1945, ♀ paratype; 6 March 1946, ♀ ♂ paratype (H. Sick, AMNH); Petrópolis, 850 m, 2 Nov. 1945, 2 ♀ paratypes (H. Sick, AMNH). *São Paulo:* Jequirituba, Cidade de São Paulo, 22-23 Dec. 1945 (H. Sick, AMNH).

Achaearanea porteri (Banks)

Map 1

Theridion porteri Banks, 1896, in Blatchley, Ann. Rept. Indiana Geol. Surv., 21: 203. Female syntypes from Porters Cave, Indiana, in the Museum of Comparative Zoology.

Achaearanea porteri, — Levi, 1955, Amer. Mus. Novitates, no. 1718: 30, figs. 71-75, 80-82, ♀, ♂; 1959, Bull. Mus. Comp. Zool., 121: 6.

Distribution. Eastern United States, West Indies to Panama (Map 1).

Additional Records. United States. North Carolina. Durham Co.: Duke Forest, Apr. 1935 (A. M. Chickering). *Missouri.* Laclede Co.: cave (G. Kastler). *Arkansas.* Washington Co.: 15 mi. S of Prairie Grove (M. Hite). *Texas.* Austin, 1909 (R. V. Chamberlin). *Kansas.* Douglas Co.: Natural History Reservation, July 1960 (H. Fitch). *Mexico. Nuevo León:* El Potosí, June 1938 (H. Hoogstraal).

Achaearanea rupicola (Emerton)

Map 1

Theridion rupicola Emerton, 1882, Trans. Connecticut Acad. Sci. 6: 14, pl. 2, fig. 2, ♀, ♂. Syntypes from Peabody, Massachusetts, in the Museum of Comparative Zoology.

Achaearanea rupicola, — Levi, 1955, Amer. Mus. Novitates, no. 1718: 21, figs. 47-52, 56, ♀, ♂.

Distribution. Eastern United States (Map 1).

Additional records. Ohio. Holmes Co.: Glenmont, 3 June 1958, ♀, under wood in dry oak forest (J. A. Beatty). Wayne Co.: Springville, Oct. 1958, ♀ (J. A. Beatty).

Achaearanea tepidariorum (C. L. Koch)

Map 1

Theridium tepidariorum C. L. Koch, 1841, Die Arachniden, 8: 75, figs. 646-648, ♀, ♂. From greenhouses of the botanical gardens, Erlangen, Bavaria.

Achaearanea tepidariorum, — Levi, 1955, Amer. Mus. Novitates, no. 1718: 32, figs. 69-70, 83-84, ♀, ♂.

Note. The specific name is an adjective in the genitive plural and has to keep its ending.

Distribution. Cosmopolitan. The species may be native to South America. While *A. tepidariorum* is one of the commonest house spiders its distribution is not as well known as might be suspected (Map 1). Its absence in areas of Canada and western states may be due to field collectors not collecting in cities where it thrives in buildings. It has not been recently collected in the West Indies and Mexico. In Peru it has been found in a field.

Records. Canada. Nova Scotia (Emerton, 1920, Trans. Roy. Canadian Inst. 12: 310). *Ontario:* Rockport (W. Creighton); Toronto; Port Credit; Amherstburg. *British Columbia.* Vancouver Island: Qualicum (R. Guppy); Wellington. *United States* (counties). *Maine:* Androscoggin; Cumberland; Hancock; Lincoln. *New Hampshire:* Carroll; Hillsboro. *Vermont:* Addison. *Massachusetts:* Barnstable; Bristol; Essex; Middlesex; Norfolk; Plymouth; Suffolk; Worcester. *Connecticut:* Fairfield; Hartford; New Haven; Windham. *New York:* Cattaraugus; Jefferson; Monroe; Nassau; Oneida; Putnam; Saint Lawrence; Suffolk; Sullivan; Thompkins; Wyoming. *New Jersey:* Bergen; Mercer. *Pennsylvania:* Franklin; Montgomery. *Ohio:* Ashland; Ottawa; Richland; Wayne. *Maryland:* Washington; Montgomery. *West Virginia:* Ohio. *Virginia:* Albemarle; Fairfax. *Kentucky:* Campbell. *Tennessee:* Davidson; Roane; Robertson; Sevier; Van Buren. *North Carolina:* Avery; Buncombe; Haywood; Mecklenburg; Moore; New Hanover; Orange; Swain; Union; Wake; Watauga. *South Carolina:* Charleston. *Georgia:* Fulton; Habersham; Turner. *Florida:* Alachua; Low Key in Florida Bay; Orange. *Alabama:* Baldwin; Calhoun; Dallas; Lee; Madison; Mobile; Morgan; Sumter; Tallapoosa; Tuscaloosa. *Mississippi:* Forrest; Jackson; Pike. *Louisiana:* East Baton Rouge; Lincoln; Orleans; Richland; Vernon. *Michigan:* Chippewa; Gladwin; Kalamazoo; Lapeer; Macomb; Midland; Oceana. *Indiana:* Floyd; Putnam. *Wisconsin:* Clark; Crawford; Dane; Door; Grant; Iowa; Kenosha; Lafayette; Marathon Milwaukee; Outagamie; Richland. *Illinois:* Cook; Hardin; Jackson; Monroe; Saint Clair. *Minnesota:* Mille Lacs; Olmsted; Winona. *Iowa:* Story. *Missouri:* Cole; Jackson; Saline; St. Louis; Vernon. *Arkansas:* Benton; Washington. *Kansas:* Bourbon; Harper; Riley. *Texas:* Angelina; Aransas; Galveston; Harris; Harrison; Henderson; Jefferson; Jim Wells. *Colorado:* Denver. *Washington:* King; Thurston. *Oregon:* Benton; Coos; Douglas;

Hood; Josephine; Lane; Multnomah. *California:* Kern; Los Angeles; Marin; Mariposa; Mendocino; Orange; San Diego; Santa Barbara.

Hawaii: Oahu.

Bermuda Islands. Costa Rica: Cartago (N. L. H. Krauss, AMNH). *British Guiana.* Tumatumari (F. E. Lutz). *Ecuador. Azuay:* Lago Zurucuchu, 18 km W of Cuenca (E. I. Schlinger, E. S. Ross, CAS). *Peru. Loreto:* Bogueron, 470 m (F. Woytkowski, AMNH). *Huánuco:* Carpish, 20 km E of Acomayo (F. Woytkowski, AMNH); Tingo María (numerous collections); Divisoria (F. Woytkowski, AMNH). *Lima:* Lima, cotton field (W. Weyrauch). *Junín:* Uteuyacu (F. Woytkowski, AMNH); Colonia del Perené (E. I. Schlinger, E. S. Ross, CAS). *Ica:* N. Chincha Isl. (W. Vogt, AMNH). *Brazil. Minas Gerais:* Belo Horizonte (N. L. H. Krauss, AMNH); near Patrocínio (G. Andrews); Ouro Preto (N. L. H. Krauss, AMNH); Minhas Serinha, Diamantina (E. Cohn, AMNH); Vicosa (Hambleton, AMNH). *Guanabara:* Teresópolis (H. Sick, AMNH). *São Paulo:* Cidade São Paulo (H. Sick, AMNH). *Paraná:* Curitiba (N. L. H. Krauss, AMNH). *Santa Catarina:* Pinhal, 700 m (A. Maller); Nova Teutonia, lat 27°11′N, long 52°23′W (F. Plaumann, SMF). *Rio Grande do Sul:* Pelotas (C. Biezanko, AMNH). *Uruguay.* Montevideo (C. Biezanko, AMNH). *Paraguay.* Caazapá: Pastoreo (D. Nees); Itapua: Encarnación (C. J. D. Brown). *Argentina.* Buenos Aires (SMF). *Chile. Antofagasta:* Taltal (H. Zapfe); Antofagasta (Dr. Macchiavello). *Santiago:* Santiago (SMF).

Achaearanea inops sp. n.

Figure 43

Type. Male holotype from Akaramukra Rapids, Upper Essequibo River, British Guiana, 4 Oct. 1937 (W. G. Hassler) in the American Museum of Natural History. The specific name is an arbitrary combination of letters.

Description. Carapace dusky gray, sternum gray, legs dusky but lighter than carapace. Abdomen gray, darker on posterior of dorsum and on venter. Anterior median eyes slightly larger than others, three-quarters diameter apart, one-quarter from laterals. Posterior eyes their diameter apart. Total length 1.2 mm. Carapace 0.71 mm long, 0.65 mm wide. First femur, 0.88 mm. Second patella and tibia, 0.66 mm; third, 0.48 mm; fourth, 0.67 mm.

Diagnosis. The course of the duct inside the tegulum (Fig. 43) and the three tips of the cymbium separate this species from *A. hirta.*

Achaearanea uviana sp. n.

Figure 44

Type. Male holotype from Utcuyacu, Junín, 1600-2200 m elev., Peru, 4 April 1948 (F. Woytkowski), in the American Museum of Natural History. The specific name is an arbitrary combination of letters.

Description. Carapace, sternum, legs dark grayish brown, proximal ends of femora lighter. Abdomen black with a white stripe going down on each side and a pair of white spots side by side on venter. Anterior median eyes slightly larger than others, their radius apart, almost touching laterals. Posterior eyes a little less than their diameter apart. Total length 1.8 mm. Carapace 0.94 mm long, 0.78 mm wide. First femur, 1.36 mm; patella and tibia, 1.44 mm; metatarsus, 1.30 mm; tarsus, 0.63 mm. Second patella and tibia, 0.98 mm; third, 0.69 mm; fourth, 0.94 mm.

Diagnosis. The long cymbium, expanded at its tip (Fig. 44) separates this species from other *Achaearanea.*

Achaearanea sicki sp. n.

Figures 48, 70-71

Type. Male holotype, from Teresópolis, Est. Guanabara, 900-1000 m elev., Brazil, 7-9 Nov. 1945 (H. Sick), in the American Museum of Natural History. The species is named after its collector Dr. H. Sick.

Description. Carapace, sternum dark brown. Legs red-brown. Abdomen very dark with typical coloring: sides with black patches, separated by irregular white lines; a white line above spinnerets. Male with anterior half of abdomen dark, posterior half light. Anterior median eyes subequal or slightly larger than others. Anterior median eyes one diameter apart, almost touching laterals. Posterior eyes one diameter apart. Eyes of male slightly closer together. Abdomen higher than long. Total length of female 3.6 mm. Carapace 1.3 mm long, 1.1 mm wide. First femur, 1.9 mm; patella and tibia, 1.8 mm; metatarsus, 1.6 mm; tarsus, 0.7 mm. Second patella and tibia, 1.2 mm; third, 1.0 mm; fourth, 0.72 mm. Total length of male 2.1 mm. Carapace 0.85 mm long, 0.69 mm wide. First femur, 1.23 mm; patella

and tibia, 1.27 mm; metatarsus, 0.80 mm; tarsus, 0.41 mm. Second patella and tibia, 0.90 mm; third, 0.63 mm; fourth, 0.91 mm.

Diagnosis. The epigynum of this species is flat with an indistinct opening (Fig. 71); the seminal receptacles are oval and the connecting ducts very short (Fig. 70). This species can be separated from all other *Achaearanea* by the forked embolus of the male (Fig. 48).

Records. 2 ♀ paratypes collected with holotype.

Achaearanea pallipera nomen novum

Figure 49

Theridium pallipes Keyserling 1891, Die Spinnen Amerikas, Brasilianische Spinnen, p. 191, pl. 6, fig. 138, ♂. Male type from Serra Vermelha, Est. Rio de Janeiro [Guanabara], Brazil, in the British Museum, examined.

Note. Keyserling's name is a junior homonym of *Linyphia pallipes*, Lucas, 1846 which was placed by Walckenaer (1847, Histoire Naturelle des Insectes Aptères, 4: 497) in *Theridion*.

Description. Carapace, sternum pale orange-yellow, some gray in eye region. Legs light gray, proximal ends of femora pale orange-yellow. Abdomen black except for a light ring around spinnerets and white triangular spot pointing posteriorly at anterior end of dorsum. Anterior median eyes almost twice the diameter of others, two-thirds their diameter apart, almost touching laterals. Posterior median eyes one and one-half diameters apart, one diameter from laterals. Abdomen oval, one and one-half times longer than wide, slightly projecting above spinnerets, resembling that of species belonging to the genus *Chrysso*. Total length 2.3 mm. Carapace 1.0 mm long, 0.9 mm wide. First femur, 1.7 mm; patella and tibia, 1.6 mm; metatarsus, 1.3 mm; tarsus, 0.7 mm. Second patella and tibia, 1.0 mm; third, 0.7 mm; fourth, 1.0 mm.

Figure 49 was prepared from the holotype.

Record. Brazil. Guanabara: Rio de Janeiro, ♂ (E. Germain, MNHN).

Achaearanea kaspi sp. n.

Figures 50-51

Type. Female holotype from Carpish, 20 km east of Acomayo, 2800 m elev., Huánuco, Peru, 9-12 Oct. 1946 (F. Woytkowski), in the American Museum of Natural History. The specific name is an arbitrary combination of letters.

Description. Carapace dark grayish brown, with a lighter patch on each side. Sternum brown with a darker border that widens opposite each coxa, and a black spot in middle. Legs banded light and dark brown, light bands slightly narrower than dark ones; palpi and coxae light brown. Abdomen with two white wavy lines that fuse in middle of dorsum and continue as a single line to spinnerets; the two wavy lines enclose some black and white patches in front. Another white line around anterior and above pedicel continues on sides as a series of white spots. Sides with black streaks. Venter with two small black marks posterior to epigynum and another two anterior to spinnerets. Eyes subequal in size. Anterior median eyes three-quarters diameter apart, three-quarters diameter from laterals. Posterior median eyes one diameter apart, one and one-half diameters from laterals. Total length 6.8 mm. Carapace 2.7 mm long, 2.2 mm wide. First femur, 5.0 mm; patella and tibia, 5.6 mm; metatarsus, 4.6 mm; tarsus, 1.5 mm. Second patella and tibia, 3.5 mm; third, 2.3 mm; fourth, 4.0 mm.

Diagnosis. The opening is in a transverse dark spot in the epigynum (Fig. 51). The shape of opening and spot separate the species from *A. leguiai.*

Achaearanea acoreensis (Berland), new combination

Map 1

Theridion acoreensis Berland, 1932, Ann. Soc. Ent. France, 101: 74, figs. 1, 2, ♀. Female holotype from the Azores in the Muséum National d'Histoire Naturelle, Paris. — Machado, 1941, Publ. Instituto de Zool. "Augusto Nobre," no. 3: 22, figs. 18-21, ♀, ♂.

Achaearanea geochares Levi, 1955, Amer. Mus. Novitates, no. 1718: 20, ♀, ♂. Male holotype from Monterey, California, in the American Museum of Natural History. NEW SYNONYMY.

American distribution. California (Map 1). This species might have been introduced into the United States with grapes. However a female *Achaearanea* from New Zealand determined as *Theridion tubercula* (Urquhart) by Miss E. B. Bryant seems to be this species. Possibly *A. acoreensis* is a cosmopolitan species.

Achaearanea gigantea (Keyserling), new combination

Figures 52-54

Theridium giganteum Keyserling, 1884, Die Spinnen Amerikas, Theridiidae, 2(1): 31, pl. 1, fig. 15, ♀. Female lectotype here designated from Maraynioc, [Junín, prov. Tarma], Peru, in the Polish Academy of Sciences, Warsaw, examined.

This large species has the epigynum sclerotized and swollen (Figs. 53, 54). The illustrations were made from specimens in the British Museum.

Record. Peru. Junín: Huancayo, 3200 m, Aug. 1940 (W. Weyrauch, AMNH); 60 km E of Carhuamayo, 15 Sept. 1954 (E. I. Schlinger, E. S. Ross, CAS).

Achaearanea leguiai (Chamberlin), new combination

Figures 55-56

Theridion leguiai Chamberlin, 1916, Bull. Mus. Comp. Zool., 60: 229, pl. 15, figs. 7-10, ♀. Female holotype from Conservidayo River [Conservidayoc, Cuzco], Peru, in the Museum of Comparative Zoology, examined.

Record. Ecuador. Napo Pastaza: Mera, 12 Feb. 1955, ♀ (E. I. Schlinger, E. S. Ross, CAS), uncertain determination.

Achaearanea anastema sp. n.

Figures 57-59

Type. Female holotype from Caracas, Venezuela, Dec. 1887-Feb. 1888 (E. Simon), in the Muséum National d'Histoire Naturelle, Paris (no. 3811). The specific name is an arbitrary combination of letters.

Description. Color of carapace reddish brown. Sternum, legs yellow-brown. Abdomen yellowish gray with a white transverse pigment stripe across highest portion (Fig. 59). Venter with some gray pigment. Eyes subequal in size. Anterior median eyes their diameter apart, almost touching laterals. Posterior median eyes one diameter apart, two-thirds diameter from laterals. Abdomen very high (Fig. 59). Total length 1.5 mm. Carapace 0.55 mm long, 0.45 mm wide. First femur, 0.97 mm; patella and tibia, 0.78 mm; metatarsus, 0.65 mm; tarsus, 0.38 mm. Second patella and tibia, 0.59 mm; third, 0.41 mm; fourth, 0.59 mm.

Diagnosis. This species is close to *A. conjuncta* (Gertsch and Mulaik) but differs by having the openings of the epigynum hidden behind a lip (Fig. 58). Figure 57 shows the internal genitalia from slightly posterior.

Achaearanea banosensis sp. n.

Figures 60-61

Type. Female holotype from Baños, Tungurahua Prov., Ecuador, 15-21 June 1943 (H. E. and D. L. Frizzell) in the Museum

of Comparative Zoology. The species is named after the type locality.

Description. Carapace gray-brown. Sternum yellow-brown with darker brown border and streaks. Legs yellow-brown with wide but indistinct darker bands. Abdomen black, white and brown with a white line from highest point to spinnerets and a wavy white line going from middle of dorsum down each side. The white lines do not quite touch on dorsum but split in two. Abdomen black anterior to line; posterior to line a brown band, followed by black. Eyes subequal in size. Anterior median eyes two-thirds diameter apart, one-quarter diameter from laterals. Posterior eyes one diameter apart. Chelicerae with one tooth on anterior margin. Total length 5.0 mm. Carapace 1.9 mm long, 1.5 mm wide. First femur, 3.1 mm; patella and tibia, 3.0 mm; metatarsus, 2.7 mm; tarsus, 0.9 mm. Second patella and tibia, 1.9 mm; third, 1.4 mm; fourth, 2.3 mm.

Diagnosis. The epigynum has an oval depression showing two black spots inside. Posterior to the depression is a swelling; anterior to the swelling, posterior to the opening, is a black lip (Fig. 61). The swelling and very short connecting ducts (Fig. 60) separate the species from *A. tepidariorum*.

Records. Ecuador. Tungurahua: Baños, 1800 m, July 1938, Apr. 1939 ♀ (W. C. Macintyre). *?Pichincha:* Río Pilatón, W slope of Andes, 1000-1200 m, Sept. 1944, ♀ (G. W. Prescott).

Achaearanea koepckei sp. n.

Figures 64-66

Type. Female holotype from Hacienda Taulis, lat 6°50′S, long 79°10′W, Cajamarca, Peru, cleared area in mountain virgin forest, 1700 m elev., 29 April 1954 (H. W. Koepcke), in the Senckenberg Museum (no. SMF 10950/1). The species is named after the collector.

Description. Carapace, sternum, legs yellow-brown with distal ends of tibiae darker. Abdomen gray with an anterior dorsal, transverse, white line and dark patches and minute white pigment spots on dorsum (Fig. 64), and a short longitudinal white line above spinnerets. Venter of abdomen with irregular dark spots, a transverse band behind epigynum and two dark spots anterior to spinnerets. Anterior median eyes slightly larger than others, their diameter apart, their radius from laterals. Posterior median eyes two-thirds diameter apart, their diameter

from laterals. Chelicerae with a blunt tooth on anterior margin. Total length 5.8 mm. Carapace 1.9 mm long, 1.5 mm wide. First femur, 2.9 mm; patella and tibia, 3.0 mm; metatarsus, 2.3 mm; tarsus, 1.1 mm. Second patella and tibia, 2.2 mm; third 1.4 mm; fourth, 2.3 mm.

Diagnosis. The elbowed connecting ducts (Fig. 65) separate *A. koepckei* from *A. cinnabarina* and *A. sicki.*

Achaearanea chilensis sp. n.

Figures 67-69

Type. Female holotype from Zapallar, Aeoncagua, Chile, 27 Nov. 1950 (E. S. Ross, A. E. Michelbacher), in the California Academy of Sciences. The species is named after the country where it is found.

Description. Carapace grayish yellow. Sternum yellow-white with dark brown spots. Legs yellow-white with small black spots and distal ends of segments brown. Abdomen with indistinct gray streaks on sides, somewhat similar to *A. tepidariorum.* Anterior median eyes smaller than others, one diameter apart, one-quarter diameter from laterals. Posterior eyes two-thirds diameter apart. Abdomen with a large posterior, dorsal tubercle (Fig. 67). Total length 3.2 mm. Carapace 1.04 mm long, 0.94 mm wide. First femur, 2.30 mm; patella and tibia, 2.10 mm; metatarsus, 1.95 mm; tarsus, 0.78 mm. Second patella and tibia, 1.27 mm; third, 0.89 mm; fourth, 1.40 mm.

Diagnosis. The epigynum has a median depression with a posterior lip (Fig. 69). The long ducts (Fig. 68) separate *A. chilensis* from *A. lota.*

Record. 1 ♀ paratype collected with holotype.

Achaearanea analista sp. n.

Figures 72-74

Type. Female holotype from Nova Teutonia, lat 27°11′S, long 52°23′W, Santa Catarina, Brazil (F. Plaumann), in the Senckenberg Museum (no. RII/13455/1). The specific name is an arbitrary combination of letters.

Description. Carapace bright yellow, eye region deep black. Sternum yellow with a black spot on each anterior lateral corner. Legs yellow. Abdomen whitish with well-defined black spots (Fig. 72). Eyes subequal in size. Anterior median eyes one

diameter apart, almost touching laterals. Posterior eyes two-thirds diameter apart. Total length 2.9 mm. Carapace 1.00 mm long, 0.88 mm wide. First femur, 1.50 mm; patella and tibia, 1.50 mm; metatarsus, 1.27 mm; tarsus, 0.55 mm. Second patella and tibia, 0.99 mm; third, 0.70 mm; fourth, 1.16 mm.

Diagnosis. The epigynum (Fig. 74) is quite similar to that of *A. cinnabarina;* however, this species is smaller and the coloration (Fig. 72) differs.

Record. Brazil. Espírito Santo: Santa Teresa, Jan. 1959, ♀ (A. M. Nadler, AMNH).

Achaearanea caqueza sp. n.

Figures 75-76

Type. Female holotype from 22 km SE of Cáqueza, Cundin Amarca, Colombia, 10 March 1955 (E. I. Schlinger, E. S. Ross), in the California Academy of Sciences. The specific name is a noun in apposition after the type locality.

Description. Carapace, sternum, legs yellow-brown. Abdomen with dorsum brown and a white line around anterior with a short median white line branching off. Also an indistinct large V-shaped mark on dorsum with two white lines going down sides. Venter with a white spot adjacent and behind epigynum, occupying one-third of the area between epigynum and spinnerets. Eyes subequal in size. Anterior median eyes two-thirds diameter apart, one-third from laterals. Posterior median eyes slightly oval. The shorter diameter of posterior median eyes one and one-third diameters apart and the same distance from laterals. Abdomen without tubercle. Total length 5.3 mm. Carapace 2.2 mm long, 1.9 mm wide. First femur, 2.9 mm; patella and tibia, 3.3 mm; metatarsus, 2.7 mm; tarsus, 1.1 mm. Second patella and tibia, 2.2 mm; third, 1.8 mm; fourth, 2.7 mm.

Diagnosis. The epigynum has a dark sclerotized oval area on a relatively flat shield that is only slightly arched behind opening. The relative flatness of the epigynum separates this species from those allied to *A. giganteum.* The large size of the species separates it from the smaller *A. apex* with its similar epigynum. The coloration separates it from *A. cinnabarina* and *A. analista.*

Achaearanea migrans (Keyserling), new combination

Figures 77-83; Map 2

Theridium migrans Keyserling, 1884, Die Spinnen Amerikas, Theridiidae, 2(1): 18, pl. 1, fig. 6, ♀. Female lectotype here designated from

Lechugal, Tumbes, Peru, in the Polish Academy of Sciences, Warsaw, examined. According to a letter received from J. Prószyński no specimens could be located from Pumamarca, the locality published. The type locality may have been in error.

Tidarren fordum luctuosum Caporiacco, 1954, Comm. Pontifica Acad. Sci., 16:77. Female holotype from St. Jean du Maroni, French Guiana, in the Muséum National d'Histoire Naturelle, Paris, examined. NEW SYNONYMY.

Note. Chamberlin and Ivie (1934, Bull. Univ. Utah, biol. ser., 2(4): 11) placed this species in *Tidarren.* They probably did not examine specimens.

Description. Clypeus, sternum, legs almost black. Abdomen black with white stripes on dorsum (Fig. 83), and a white spot on the venter. The center of the epigynum lacks pigment and is brown. Anterior median eyes slightly larger than others and on slight tubercles. Anterior median eyes slightly less than their diameter apart, one-quarter diameter from laterals. Posterior median eyes one diameter apart, a little more than one diameter from laterals. Chelicerae with two teeth on anterior margin. Epigynum with two ducts visible in an area free of pigment (Figs. 78, 80, 82), very distinct from other species, but quite variable in shape. Total length of female type, 5.0 mm. Carapace 1.9 mm long, 1.6 mm wide. First femur, 3.2 mm; patella and tibia, 3.2 mm; metatarsus, 3.0 mm; tarsus, 0.9 mm. Second patella and tibia, 1.9 mm; third, 1.4 mm; fourth, 2.5 mm.

Figures 77-78 were prepared from the lectotype, Figures 79-80 from specimens in the British Museum coming from Peru, Figures 81-83 from the holotype of *Tidarren fordum luctuosum.*

Distribution. Northern South America (Map 2).

Records. Venezuela. Carabobo: La Cumbre, S of San Estebán, 1888 (E. Simon, MNHN). *British Guiana:* Kuyuwini Landing, Kuyuwini River (W. G. Hassler, AMNH). *Peru. Huánuco:* Tingo María (W. Weyrauch; J. C. Pallister, AMNH; E. I. Schlinger, E. S. Ross, CAS). *Junín:* Utcuyacu (F. Woytkowski). *Brazil. Amazonas.* (BMNH). *Espírito Santo:* Santa Teresa, Jan. 1959 (A. M. Nadler, AMNH), doubtful determination. *Paraná.* (BMNH).

Achaearanea pilaton sp. n.

Figures 84-85

Type. Female holotype from Río Pilatón, west slope of Andes, 1000-1200 m elev., Ecuador, Sept. 1944 (G. W. Prescott), in the

Museum of Comparative Zoology. The specific name is a noun in apposition after the type locality.

Description. Carapace yellow to brown, dusky in eye region. Sternum yellow. Legs yellow with brown bands in middle and distal ends of segments. Abdomen with a white pigment line around anterior, the dorsum with three pairs of wide dark brown bands going down sides, spaces between of equal width. In center of dorsum some white pigment and several brown spots. Venter with a black transverse line behind epigynum and two black spots anterior to spinnerets and some small spots of white pigment distributed in between. Anterior median eyes slightly larger than others, their radius apart, their radius from laterals. Posterior median eyes their diameter apart, one and one-half diameters from laterals. Abdomen suboval, longer than high. Total length 4.3 mm. Carapace 1.8 mm long, 1.6 mm wide. First femur, 3.0 mm; patella and tibia, 3.5 mm; metatarsus, 2.9 mm; tarsus, 1.1 mm. Second patella and tibia, 2.0 mm; third, 1.6 mm; fourth, 2.5 mm.

Diagnosis. The internal genitalia (Fig. 84) are heavily sclerotized, and the ducts are longer than the related *A. leguiai;* the posterior lip of the epigynum (Fig. 85) is wider, and the opening smaller. The swelling of the epigynum near the posterior border and the bordered opening separate it from *A. migrans.*

Record. 1 ♀ paratype collected with holotype.

Achaearanea jequirituba sp. n.

Figures 98-99

Type. Female holotype from Jequirituba, Cidade de São Paulo, Brazil, 22-23 Dec. 1945 (H. Sick), in the American Museum of Natural History. The specific name is a noun in apposition after the type locality.

Description. Carapace gray-brown. Sternum brown. Legs brown, distal segments darker. Anterior of abdomen black; in middle of abdomen a white line goes toward each side; posterior to white line, abdomen is lighter; a white line above spinnerets. Venter black, sometimes with a pair of white spots. The abdomen is variable in color. The coloration is like that of many species of *Achaearanea.* Eyes subequal in size. Anterior median eyes one diameter apart, almost touching laterals. Posterior median eyes a little less than their diameter apart, two-thirds their shorter diameter from laterals. Abdomen without tubercle. Total length 2.7 mm. Carapace 1.05 mm long, 0.82 mm wide. First femur,

1.30 mm; patella and tibia, 1.30 mm; metatarsus, 1.00 mm; tarsus, 0.55 mm. Second patella and tibia, 0.91 mm; third, 0.55 mm; fourth, 1.01 mm.

Diagnosis. The epigynum has a squarish opening with a sclerotized rim; posterior is a shallow groove (Fig. 99). The ducts are very short (Fig. 98). The groove behind the opening and the shape of the opening separate it from other species.

Record. Brazil. Guanabara: Sumaré, Cidade Rio de Janeiro, 200-300 m, Jan. 1946 (H. Sick, AMNH). *Est. São Paulo:* 2 ♀ paratypes collected with holotype; Ribeirão Pires, Dec. 1945, 3 ♀ paratypes (H. Sick, AMNH). *Paraguay:* 1891-1893 (Dr. Bohls, BMNH).

Achaearanea bellula (Keyserling), new combination

Figures 86-90

Theridium bellulum Keyserling, 1891, Die Spinnen Amerikas, Brasilianische Spinnen, 3: 180, pl. 6, fig. 125, ♀. Female holotype from Neu Freiburg [Nova Friburgo, Guanabara], Brazil, in the British Museum, examined.

The abdomen of this species is higher than long (Fig. 89) and is orange in color. The generic placement is doubtful. A specimen from Santa Catarina has the more streaked coloration characteristic of *Achaearanea* and a slightly different epigynum (Fig. 88). The abdomen of the minute male (1.5 mm total length) is higher than that of the female and has setae above the pedicel (Fig. 89). The carapace is highest in the thoracic region, having two swellings with a depression between.

Figures 86, 87 were prepared from the holotype.

Records. Brazil. Pernambuco. ♂ (SMF). *Santa Catarina:* Nova Teutonia, lat 27°11′S, long 52°23′W, ♀, ♂ (F. Plaumann, SMF).

Achaearanea alacre (Keyserling), new combination

Figures 91-92

Theridium alacre Keyserling, 1884, Die Spinnen Amerikas, Theridiidae, 2(1): 27, pl. 1, fig. 12, ♀. Female type from St. Fé de Bogotá [probably vicinity of Bogotá, Colombia] in the British Museum, examined. — ? Berland, 1913, *in* Mission du Service, Arc de Méridien Equatorial, 10(1): 86, pl. 8, figs. 16, 17, ♀.

The epigynum of this species is a heavily sclerotized flat plate with the center black (Fig. 92) and having two openings. The drawings were made from the holotype.

Records. Venezuela. Dist. Fed.: Caracas, 1887-1888, ♀ (E. Simon, MNHN).

Achaearanea pingue (Keyserling), new combination
Figures 93-94

Theridium pingue Keyserling, 1886, Die Spinnen Amerikas, Theridiidae, 2(2): 235, pl. 20, fig. 290, ♀, ♂. Female lectotype here designated from Blumenau [Santa Catarina], Brazil, in the British Museum, examined.

Description. Specimen from Uruguay. Carapace yellowish with head region a murky gray that continues as a broad band to thoracic depression; sides gray. Sternum olive-gray. Legs yellowish with gray bands as wide as intermediate areas. Abdomen with black and white pigment. A black diamond-shaped mark anterior on dorsum, a black patch on each side with white streaks going down sides behind patch; a pair of white spots, side by side, on venter. Anterior median eyes slightly smaller than others, their diameter apart, almost touching laterals. Posterior eyes their diameter apart. Total length 2.8 mm. Carapace 1.04 mm long, 0.85 mm wide. First femur, 1.56 mm; patella and tibia, 1.58 mm; metatarsus, 1.36 mm; tarsus, 0.62 mm. Second patella and tibia, 1.10 mm; third, 0.80 mm; fourth, 1.30 mm.

The epigynum has the opening in a black spot, and has a lighter, projecting posterior area (Fig. 94). The projecting posterior area is wider (extending towards the sides) in the specimen from Uruguay than in the lectotype. The seminal receptacles are dumb-bell shaped with very short ducts (Fig. 93). The illustrations were prepared from the lectotype.

Records. Uruguay: La Sierra, 26 Jan. 1899, ♀ (Silvestri, MNHN).

Achaearanea eramus sp. n.
Figures 95-97

Type. Female holotype from Sumaré, Cidade Rio de Janeiro, 300-400 m elev., Brazil, Feb. 1946 (H. Sick), in the American Museum of Natural History. The specific name is an anagram of the type locality.

Description. Carapace yellow-brown, darker in head region. Sternum yellow-brown. Legs yellow-brown with brown indistinct rings as wide as intermediate areas. Abdomen with the dorsum having a black pattern (Fig. 95); venter with indistinct black spots and a black ring around spinnerets. Eyes subequal in size. Anterior median eyes one and one-quarter diameters apart, their radius from laterals. Posterior eyes one diameter apart. Total length 3.5 mm. Carapace 1.7 mm long,

1.4 mm wide. First femur, 2.9 mm; patella and tibia, 2.9 mm; metatarsus, 2.5 mm; tarsus, 1.2 mm. Second patella and tibia, 1.8 mm; third, 1.3 mm; fourth, 2.2 mm.

Diagnosis. The larger posteriorly directed swelling of the epigynum with larger openings on the surface (Fig. 97) separates this species from *A. alacre*. The generic placement is uncertain.

Record. Brazil. Guanabara: Teresópolis, ♀ (Bruner, MNHN).

Achaearanea isana sp. n.

Figures 100-102, 113-114

Type. Male holotype from Nova Teutonia, lat 27°11′S, long 52°23′W, Santa Catarina, Brazil (F. Plaumann), in the Senckenberg Museum (no. R11/7507/1). The specific name is an arbitrary combination of letters.

Description. Carapace yellowish, eye region reddish with a narrow, red, longitudinal band in cephalic region. Margins gray. Sternum yellow. Legs yellow with narrow black and red bands. Abdomen speckled grayish white and black, genital area black; white between genital area and spinnerets. Clypeus of male with a slight groove from eyes to chelicerae, emphasized by dark pigment. Anterior eyes subequal in size, one diameter apart, touching laterals. Posterior eyes two-thirds their diameter apart. Both sexes have a rather long abdomen with a posterior dorsal tubercle (Fig. 100). Total length of female 2.2 mm. Carapace 0.69 mm long, 0.65 mm wide. First femur, 1.45 mm; patella and tibia, 1.30 mm; metatarsus, 0.93 mm; tarsus, 0.52 mm. Second patella and tibia, 0.78 mm; third, 0.55 mm; fourth, 0.91 mm. Total length of male 1.5 mm. Carapace 0.68 mm long, 0.66 mm wide. First femur, 1.82 mm; patella and tibia, 1.80 mm; metatarsus, 1.36 mm; tarsus, 0.49 mm. Second patella and tibia, 0.91 mm; third, 0.55 mm; fourth, 0.83 mm.

Diagnosis. The species is distinct from others in that the epigynum has a pair of comma-shaped openings side by side (Fig. 102) and the palpus has a cone-shaped embolus (Fig. 113).

Records. Two ♀, 2 ♂ paratypes collected with holotype.

Achaearanea rapa sp. n.

Figures 103-106

Type. Male holotype from Taguararapa [? Tacuara], Alto-Parana, Paraguay [? 1908], in the American Museum of Natural History. The specific name is an arbitrary combination of letters.

Description. Carapace yellow, sometimes dusky at sides. Sternum, legs, yellow. Abdomen of male light grayish with darker and white marks; venter darker gray. Abdomen of female with pattern like *A. nigrovittata* (Keyserling) with a white Y on the dorsum, having on each side a wide line going down the side and having other dark or light marks sometimes, but no two specimens look alike. Anterior median eyes slightly largest in male, subequal in female. Anterior median eyes two-thirds diameter apart, less than one-third diameter from laterals. Posterior median eyes one diameter apart, about their radius from laterals. Total length of female 2.7 mm. Carapace 1.10 mm long, 0.92 mm wide. First femur, 1.95 mm; patella and tibia, 1.76 mm; metatarsus, 1.60 mm; tarsus, 0.65 mm. Second patella and tibia, 1.04 mm; third, 1.10 mm; fourth, 1.23 mm. Total length of male 1.4 mm. Carapace 0.71 mm long, 0.59 mm wide. First femur, 1.00 mm; patella and tibia, 1.03 mm; metatarsus, 0.83 mm; tarsus, 0.45 mm. Second patella and tibia, 0.70 mm; third, 0.43 mm; fourth, 0.65 mm.

Diagnosis. The female of this species can be separated from *A. scrax* by the greater distance between seminal receptacles (Fig. 105); the palpus differs from that of *A. nigrovittata* (Keyserling) by having a thicker and shorter median apophysis and embolus (Fig. 103).

Records. ♂ paratype and several ♀ paratypes collected with holotype "Paraguay" ♀ (Germain, MNHN).

Achaearanea pussilana (Roewer), new combination

Figure 111

Theridium pusillum Keyserling. 1884, Die Spinnen Amerikas, Theridiidae, 1(1): 87, pl. 4, fig. 55, ♂. Male holotype from Uassa, French Guiana [Rio Uaçá; Amapa, Brazil], in the Polish Academy of Sciences, Warsaw, examined. Not *Theridion pusillum* Wider, 1834.

Theridion pussilanum Roewer, 1942, Katalog der Araneae, vol. 1, p. 497. New name for *Theridion pusillum* Keyserling, preoccupied.

The palpus lacks a median apophysis and the embolus is broadly attached (Fig. 111). It probably belongs to *Achaearanea*. Figure 111 was prepared from the holotype.

Achaearanea orana sp. n.

Figure 112

Type. Male holotype from Guayaquil, Guayas, Ecuador, 21 March 1942 (H. E. and D. L. Frizzell), in the Museum of Comparative Zoology. The specific name is an arbitrary combination of letters.

Description. Carapace orange-yellow; legs yellow; abdomen yellow, sides with some gray. Eyes subequal in size. Anterior median eyes one diameter apart, their radius from laterals. Posterior median eyes one diameter apart, one and one-quarter diameters from laterals. Total length 1.73 mm. Carapace 0.83 mm long, 0.73 mm wide. Second patella and tibia, 1.10 mm; third, 0.78 mm; fourth, 1.11 mm.

Diagnosis. The embolus of *A. orana* (Fig. 112) is smaller than that of *A. milagro* and *A. isana.*

Achaearanea nigrovittata (Keyserling), new combination

Figure 110; Map 2

Theridium nigrovittatum Keyserling, 1884, Die Spinnen Amerikas, Theridiidae, 2(1): 26, pl. 1, fig. 11, ♀. Female holotype from Lechugal [Tumbes], Peru, in the Polish Academy of Sciences, Warsaw, lost.

Theridium obnubilum Keyserling, 1891, Die Spinnen Amerikas, Brasilianische Spinnen, 3: 187, pl. 6, fig. 132, ♂. Male holotype from Serra Vermella, Est. Rio de Janeiro, Brazil, in the British Museum, examined. NEW SYNONYMY.

Theridion boqueronicum Kraus, 1955, Abhandl. Senckenbergischen naturf. Gesell. no. 493: 18, figs. 37-39, ♀. Female type from El Salvador in the Senckenberg Museum, examined. NEW SYNONYMY.

Achaearanea mesax Levi, 1959, Bull. Mus. Comp. Zool., 121: 74, figs. 53-56, ♀, ♂. Male holotype from Barro Colorado Island, Panama Canal Zone, in the Museum of Comparative Zoology. NEW SYNONYMY.

Note. Although the type of *T. nigrovittatum* could not be found, Keyserling's description and measurements match those given for *A. mesax.* Keyserling's illustration is a more posterior view of the epigynum than figure 55 in Levi, 1959.

Figure 110 was prepared from the type of *Theridium obnubilum.*

Distribution. Mexico, Cuba, to Paraguay (Map 2).

Additional Records. Costa Rica: Hamburg Farm (C. R. Dodge). *Venezuela. Aragua:* Maracay, ♂ (A. M. Nadler, AMNH). *Dist. Federal.* La Guaira (E. Simon, MNHN), doubtful determination. *French Guiana.* Cayenne (A. M. Nadler, AMNH). *Ecuador. Los Rios:* Pichilingue (E. I. Schlinger, E. S. Ross, CAS). *Guayas:* Guayaquil (D. L. Frizzell); Milagro (H. E., D. L. Frizzell); prov.?, Balzapampa (W. C. MacIntyre). *El. Oro:* Quebrada Bejucal, 10 km WSW of Arenillas (R. Walls); Buena Vista, 25 km SE of Machala (R. Walls). *Peru. Loreto:* Pebas, C. Cocho (Math., MNHN). *Piura:* Pariñas Valley (H. E., D. L. Frizzell); Cerro Prieto, La Breu; Quebrada Songoro (H.

E., D. L. Frizzell); Mallares, Río Chira (H. E., D. L. Frizzell). *Huánuco:* Monzón Valley, Tingo María (E. I. Schlinger, E. S. Ross, CAS). *Junín:* Colonía del Perené (E. I. Schlinger, E. S. Ross, CAS). *Brazil. Pará:* Belém, ♂ (A. M. Nadler, AMNH). *Goyás:* (MNHN). *Paraguay. Alto Parana:* Taguararapa (AMNH). *Bolivia. La Paz:* Puente Villa Yungas, 1200 m (L. Peña, ISNB).

Achaearanea micratula (Banks), new combination

Figure 109

Dipoena micratula Banks, 1909, Proc. Acad. Nat. Sci. Philadelphia, 61: 205, pl. 6, fig. 29, ♂. Male holotype from Orosi, Costa Rica, in the Museum of Comparative Zoology, examined.

Description. Carapace yellow. Eyes with blackish rings. Legs and sternum yellow. Abdomen missing. Anterior median eyes very slightly larger than posterior medians, lateral eyes a little smaller than others. Anterior median eyes more than a diameter apart, touching laterals. Posterior median eyes one diameter apart, less than one diameter from laterals. Carapace 0.50 mm long, 0.46 mm wide. First femur, 0.65 mm; patella and tibia, 0.65 mm; metatarsus, 0.48 mm; tarsus, 0.37 mm. Second patella and tibia, 0.51 mm; third, 0.35 mm; fourth, 0.51 mm.

Figure 109 was prepared from the holotype.

Achaearanea tesselata (Keyserling)

Map 2

Theridium tesselatum Keyserling, 1884, Die Spinnen Amerikas, Theridiidae, 1(1): 48, pl. 2, fig. 27, ♀. Female holotype from Nancho [?Cajamarca] Peru, in the Polish Academy of Sciences, Warsaw, examined.

Theridium picadoi Banks, 1909, Proc. Acad. Nat. Sci., Philadelphia, p. 204. Female holotype from Orosi, Costa Rica, in the Museum of Comparative Zoology, examined. NEW SYNONYMY.

Achaearanea terex Levi, 1959, Bull. Mus. Comp. Zool., 121: 74, fig. 52, ♂. Male holotype from Banes, Oriente, Cuba, in the American Museum of Natural History. NEW SYNONYMY.

Achaearanea tessclata, — Levi, 1959, *ibid.,* 121: 76, figs. 70-71, ♀.

Achaearanea picadoi, — Levi, 1959, *ibid.,* 121: 76, figs. 57-60, ♀.

Distribution. (Map 2.) Probably cosmotropical. Tamaulipas, Mexico, Cuba to Paraguay; New Guinea (Levi, 1959); also a specimen from Chittagong, hill tracts, Mahullya, 7 mi. N of Manimukh, Pakistan, March 1958 (R. Paynter).

Additional Records. Venezuela. Carabobo: Puerto Cabello (E. Simon, MNHN). *Colombia. Cauca:* 24 km S of Corinto (E. I. Schlinger, E. S. Ross, CAS). *Valle:* 27 km W of Sevilla (E. I. Schlinger, E. S. Ross, CAS). *Meta:* Restrepo (J. Bequaert). *Ecuador. Manabi:* Manta (D. L. Frizzell). *Guayas:* I. de Puná (D. L. Frizzell); Guayaquil (H. E., D. L. Frizzell). *Peru. Piura:* Quebrada Mogollón; Sullana; 6 km W of Sullana; Las Lomas; Pariñas Valley; N of Malares, Río Chira; Quebrada Songora (all H. E., D. L. Frizzell). *Huánuco:* Tingo María (J. C. Pallister, AMNH; W. Weyrauch). *Brazil. Guanabara:* Sumaré, Cidade Rio de Janeiro, 220-300 m (H. Sick, AMNH). *Paraná:* Cavinna (A. Maller). *Santa Catarina:* Nova Teutonia, lat 27°11′S, long 52°23′W (F. Plaumann, SMF). *Paraguay.* (Dr. Bohls, BMNH).

Achaearanea florendida Levi

Map 1

Achaearanea florendida Levi, 1959, Bull. Mus. Comp. Zool., 121(3): 65, figs. 17, 20-21, ♀, ♂. Male holotype from Panama Canal Zone, in the Museum of Comparative Zoology.

Distribution. Texas to Venezuela (Map 1).

Additional record. Venezuela. Aragua: Tovar, 1888, ♀ (E. Simon, MNHN).

Achaearanea milagro sp. n.

Figures 13-15, 107-108

Type. Male holotype from Milagro, Guayas, Ecuador, 4 July 1943 (H. E., D. L. Frizzell), in the Museum of Comparative Zoology. The specific name is a noun in apposition after the type locality.

Description. Carapace orange, eye region black, sometimes some faint dusky patches on sides. Sternum orange. Legs yellowish gray, proximal ends of femora yellow. Abdomen gray with black and white spots (Fig. 13). Eyes subequal in size. Anterior median eyes one and one-half diameters apart, one-third diameter from laterals. Posterior median eyes one and one-quarter diameters apart, one diameter from laterals. Total length of female 2.0 mm. Carapace 0.80 mm long, 0.66 mm wide. First femur, 1.17 mm; patella and tibia, 1.17 mm; metatarsus, 0.96 mm; tarsus, 0.60 mm. Second patella and tibia, 0.80 mm; third, 0.60 mm; fourth, 0.91 mm. Total length of male

1.6 mm. Carapace 0.78 mm long, 0.65 mm wide. First femur, 1.17 mm; patella and tibia, 1.22 mm; metatarsus, 0.73 mm; tarsus, 0.47 mm. Second patella and tibia, 0.80 mm; third, 0.59 mm; fourth, 0.80 mm.

Diagnosis. The epigynum of *A. milagro,* unlike that of other species, has a light oval depression in a white area, with an opening on each side of the depression (Fig. 15). The palpus differs from that of *A. orana* by having the embolus with a larger base (Fig. 108).

Records. Ecuador. Guayas: Milagro, 10 May 1942, 4 July 1943, ♀, ♂ paratypes (H. E., D. L. Frizzell).

Achaearanea trinidensis Levi

Map 2

Achaearanea trinidensis Levi, 1959, Bull. Mus. Comp. Zool., 121: 68, figs. 29-31, ♂. Male holotype from Trinidad in the American Museum of Natural History.

Distribution. Trinidad to Peru (Map 2).

Additional record. Peru. Junín: Utcuyacu, 1600-2200 m, March 1948. ♂ (F. Woytkowski, AMNH).

Echinotheridion gen. nov.

Type species. Echinotheridion cartum sp. n. The generic name is neuter, and derived from "spiny *Theridion.*"

Description. Small theridiid spiders, 2-3 mm total length. Carapace like that of *Achaearanea* and *Theridion.* Anterior median eyes of the known species slightly larger than others, less than their diameter apart, almost touching laterals. Eyes of posterior row equally spaced. Clypeus straight. Chelicerae (of *E. cartum*) with two anterior lightly sclerotized teeth (Fig. 119). First leg longest; fourth slightly shorter or subequal; third shortest. Legs short, first patella and tibia 1-1.2 times carapace length. Fourth coxae with a mesal spur. Abdomen suboval, higher than long (Fig. 120). Colulus absent. The coloration of the four species is similar; carapace and legs are yellowish; the legs are uniform in color and there is a white longitudinal stripe above the spinnerets.

Female with two seminal receptacles. The epigynum is a very large sclerotized plate partly overhung anteriorly by the coxal spurs which seem to be a functional part of the epigynum (Fig. 121). Males unknown.

Diagnosis. Echinotheridion differs from other theridiid spiders by the presence of spurs on the fourth coxae (Fig. 121).

Distribution. South America. One species from Venezuela, one from Ecuador, one from the Amazon Basin and one from southeastern Brazil and Paraguay (Map 3).

Map 3. Distribution of *Echinotheridion* species.

Key to species of *Echinotheridion*

1a. Posterior half of epigynum with a transverse, lightly sclerotized swelling (Fig. 116); Venezuela ..... *elicolum* sp. n.

1b. Epigynum otherwise 2

2a. Epigynum with a central protruding knob whose posterior face has a subcircular, lightly sclerotized patch (Figs. 123, 124); Ecuador ..... *otlum* sp. n.

2b. Epigynum otherwise, relatively flat 3

3a. Epigynum with a short anterior scape (sometimes broken off) having an opening below on each side (Fig. 118); southeastern Brazil to Paraguay ..... *cartum* sp. n.

3b. Epigynum with a shallow transverse, anterior groove (Fig. 126); Amazon area ..... *utibile* (Keyserling)

Echinotheridion cartum sp. n.

Figures 117-121; Map 3

Type. Female holotype from Apa [River], Paraguay, 1908-1909, in the American Museum of Natural History. The specific name is an abitrary combination of letters.

Description. Carapace yellowish, head gray. Sternum black. Legs yellowish brown. Dorsum of abdomen black with an anterior light spot, two spots on each side and a line above spinnerets (Fig. 120). Venter yellowish with a black spot between spinnerets and epigynum. Anterior median eyes slightly larger than others, three-quarters diameter apart, one-third diameter from laterals. Posterior median eyes one diameter apart, a little more than one diameter from laterals. Total length 2.4 mm. Carapace 0.91 mm long, 0.87 mm wide. First femur, 1.20 mm; patella and tibia, 1.10 mm; metatarsus, 1.01 mm; tarsus, 0.57 mm. Second patella and tibia, 0.85 mm; third, 0.71 mm; fourth, 1.07 mm.

Diagnosis. Echinotheridion cartum differs from *E. otlum* and *E. utibile* by the epigynum (Fig. 118), which is a large sclerotized shield, quite flat, with two openings anterior underneath a scape. The scape is broken off in some specimens; in others there may be a flat spine on its base (not shown in Fig. 118). The coxal spurs fit over the openings (Fig. 121). The seminal receptacles and connecting ducts show through the transparent, though heavily sclerotized, shield.

Natural History. This species has been collected in bamboo undergrowth in Teresópolis.

Records. Brazil. Guanabara: Petrópolis, 2-5 Nov. 1945 (H. Sick, AMNH); Teresópolis, March 1946 (H. Sick, AMNH). *Paraguay.* ♀ paratype collected with type.

Echinotheridion otlum sp. n.

Figures 122-123; Map 3

Type. Female from 16 km north of Manglaralto, Guayas, Ecuador, 30 Jan. 1955 (E. I. Schlinger, E. S. Ross), in the California Academy of Sciences. The specific name is an arbitrary combination of letters.

Description. Carapace, sternum, legs, yellow. Abdomen grayish with a median longitudinal white line on posterior part of dorsum and a curved white line on each side. Anterior median

eyes slightly larger than others, two-thirds diameter apart, one-quarter diameter from laterals. Posterior eyes their diameter apart. Abdomen suboval, slightly higher than long. Total length 2.4 mm. Carapace 0.91 mm long, 0.80 mm wide. First femur, 1.24 mm; patella and tibia, 1.14 mm; metatarsus, 0.98 mm; tarsus, 0.52 mm. Second patella and tibia, 0.86 mm; third, 0.71 mm; fourth, 1.14 mm.

Diagnosis. The species differs from *E. cartum* and *E. utibile* by the knob-shaped epigynum (Figs. 123, 124). The openings of the epigynum seem to be on the posterior side of the knob or around the lightly sclerotized patch on the posterior side.

Echinotheridion utibile (Keyserling), new combination

Figures 125-126; Map 3

Theridium utibile Keyserling, 1884, Die Spinnen Amerikas, Theridiidae, 1(1): 28, pl. 1, fig. 13, ♀. Female holotype from Amazonas, Brazil, in the Hope Department of Entomology, Oxford University, examined.

Description. Carapace, sternum, legs, yellow. Abdomen colorless with two dorsal, longitudinal white lines which are fused in front and behind, and continue as a single line to the spinnerets. Three white lines go down each side from the dorsal, longitudinal lines. The venter has two white spots side by side behind the epigynum. The anterior median eyes are slightly larger than the others, two-thirds their diameter apart, almost touching laterals. Posterior median eyes one diameter apart, a little less than their diameter from laterals. The abdomen is quite high. Total length 2.9 mm. Carapace 1.00 mm long, 0.91 mm wide. First femur, 1.30 mm; patella and tibia, 1.12 mm; metatarsus, 0.91 mm; tarsus, 0.53 mm. Second patella and tibia, 0.91 mm; third, 0.71 mm; fourth, 1.06 mm.

Diagnosis. The epigynum (Fig. 126) has a flat shield with a wide anterior groove. The groove is bordered on the anterior by a thin sclerotized ridge. The groove and ridge separate the species from *E. clicolum, E. otlum* and *E. cartum.*

Echinotheridion elicolum sp. n.

Figures 115-116; Map 3

Theridion cidrelicola Simon, 1894, Histoire Naturelle des Araignées, 1: 536, figs. 547, 552, 553; 1895, Ann. Soc. Ent. France, 64: 139. Female and male syntypes from Colonia Tovar, [Aragua], Venezuela, in the Muséum National d'Histoire Naturelle, Paris, examined.

When examining the syntype specimens of *Theridion cidrelicola* Simon in Paris in 1958, I found that male and female do not belong together. A label was placed in the vial indicating that the female will be chosen lectotype. This was done in accord with the usual taxonomic procedure of labelling the lectotype specimen and later publishing on it. The female was chosen lectotype at the time to avoid transferring the name to another family. On my return, I learned that Dr. W. J. Gertsch was preparing a further paper on the American Symphytognathidae. I made available the drawings and notes made on my recent European trip to reciprocate for the many courtesies he has shown me. His paper was published in 1960 (Gertsch, 1960, Amer. Mus. Novitates, no. 1981). Gertsch correctly placed the male in the genus *Lucarachne* Bryant, and designated the male as lectotype. Therefore, it is necessary for me to give the female a new name. The name is an arbitrary combination of letters.

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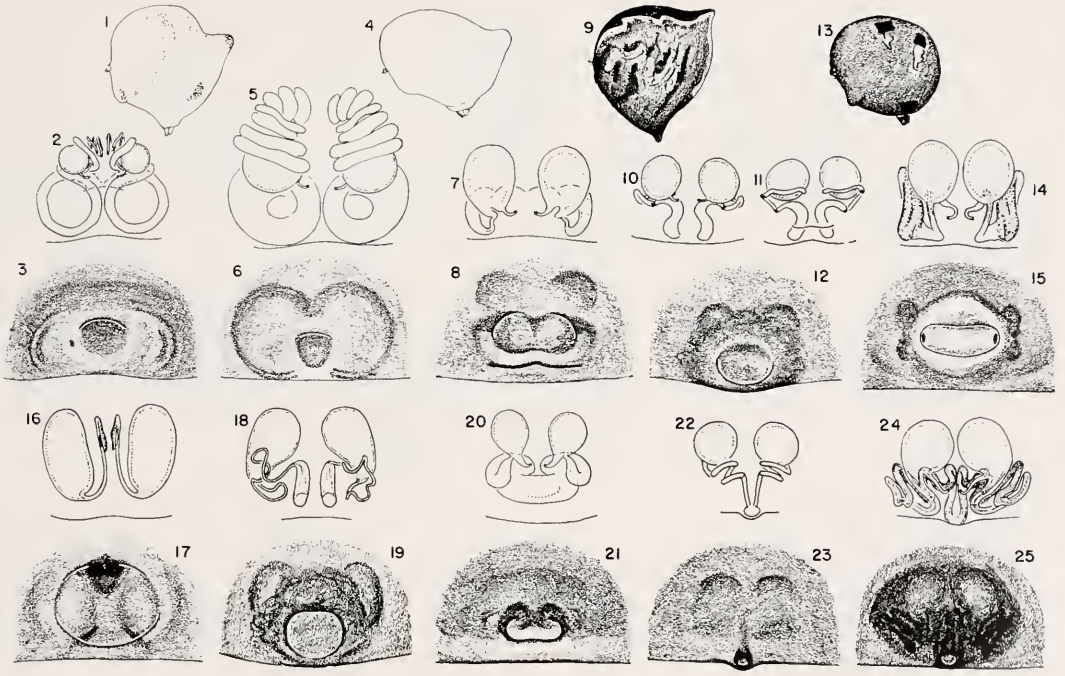
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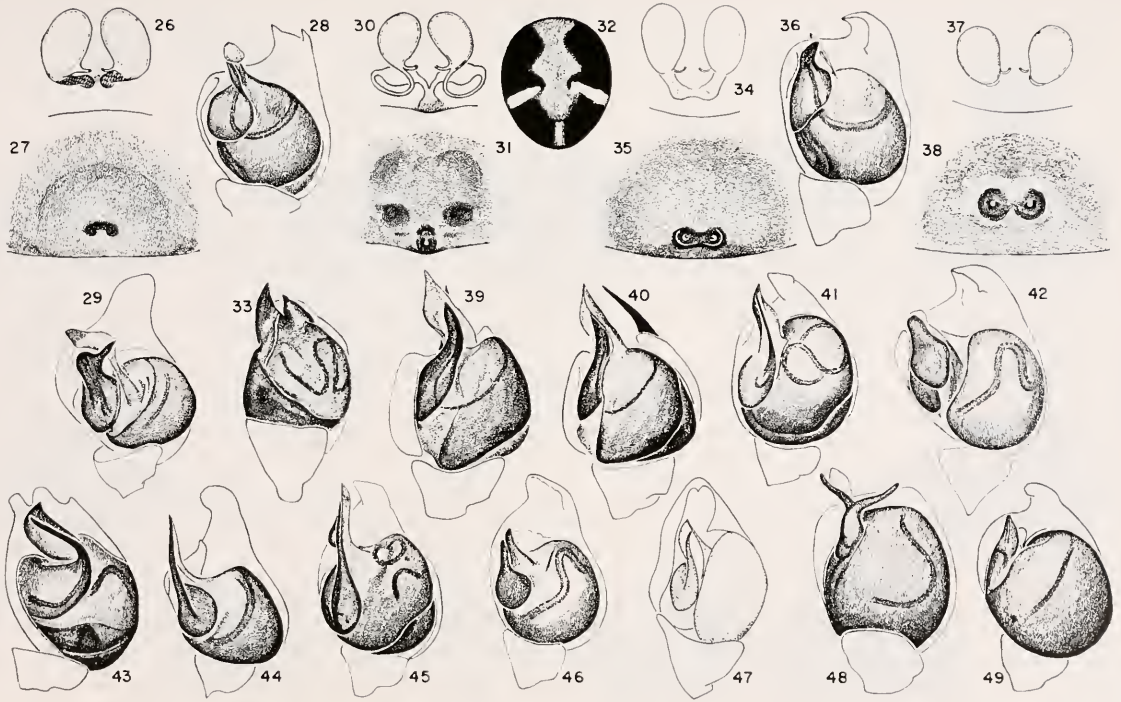
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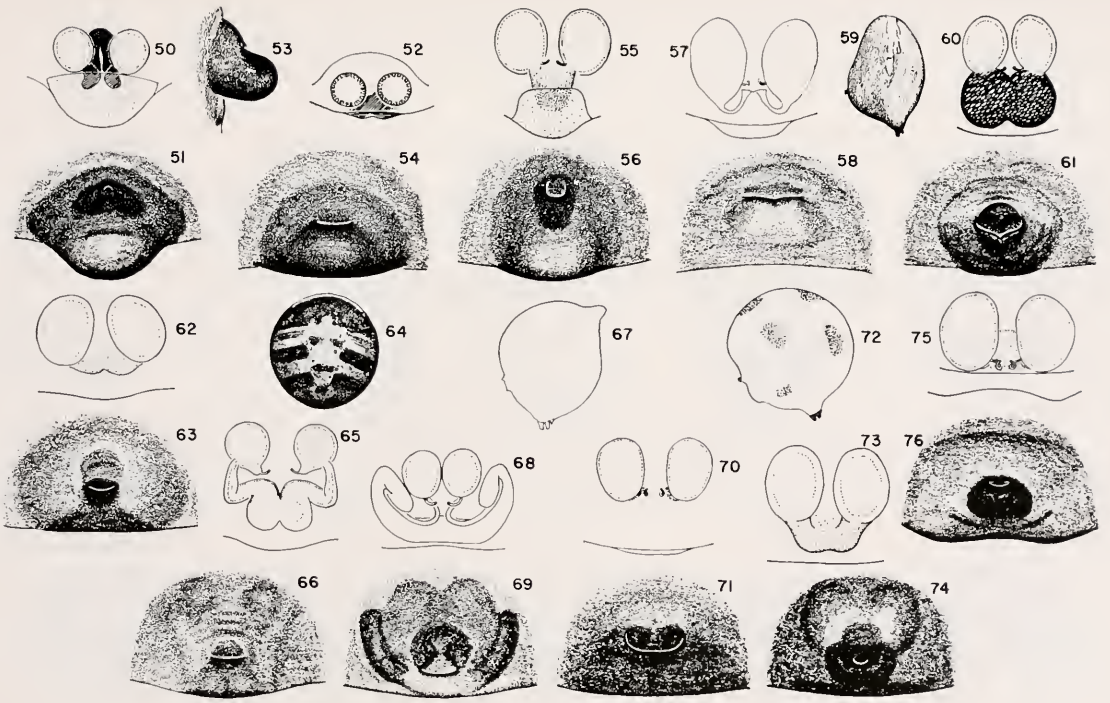
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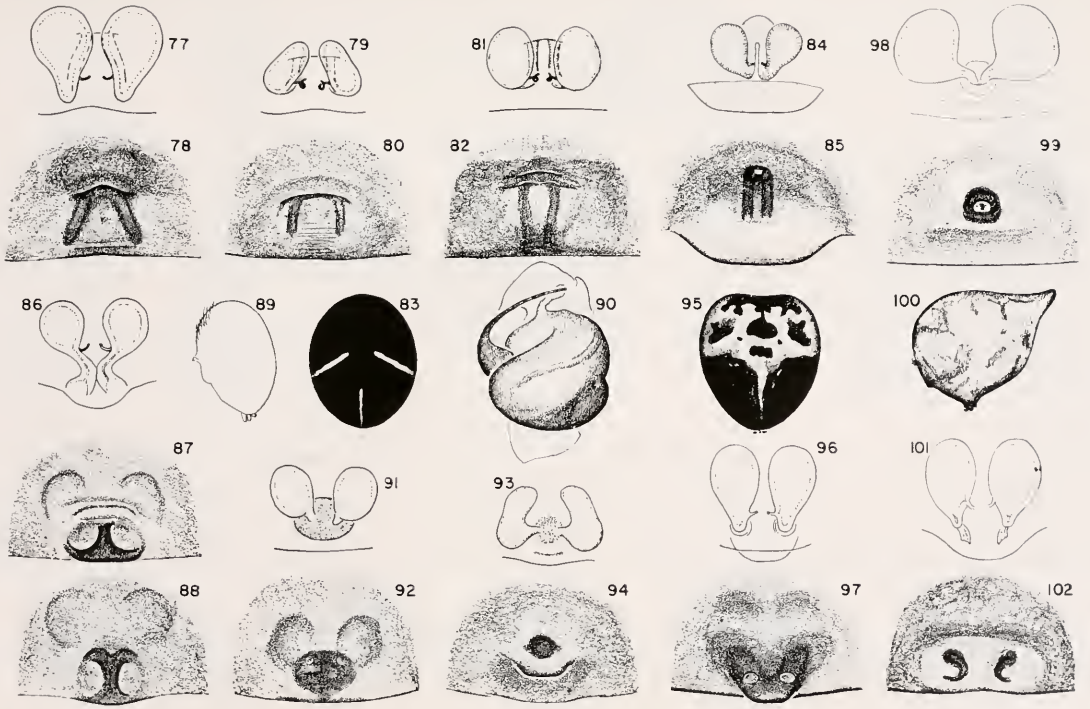
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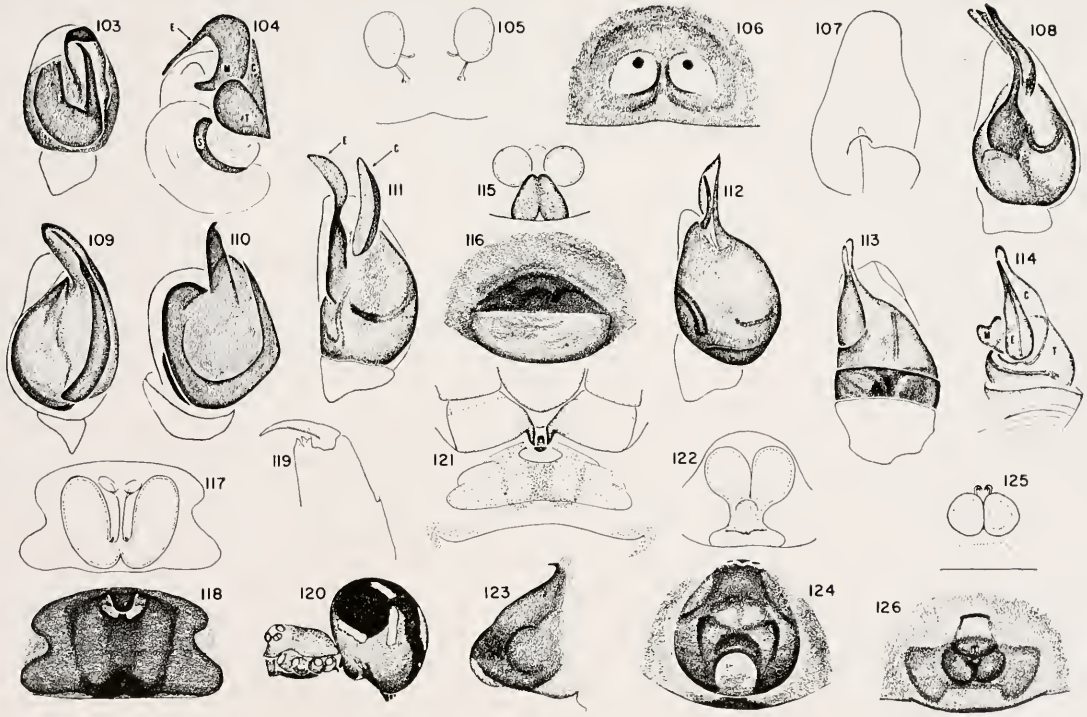
Abbreviations. C, conductor; E, embolus; M, median apophysis; T, tegulum; S, subtegulum.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Bulletin of the Museum of Comparative Zoology

AT HARVARD COLLEGE

VOL. 129, NO. 4

A REVISION OF THE GENUS *PRISTOCERA* IN THE AMERICAS (HYMENOPTERA, BETHYLIDAE)

BY HOWARD E. EVANS

WITH FIVE PLATES

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No. 4 — *A Revision of the Genus* Pristocera *in the Americas (Hymenoptera, Bethylidae)*[1]

By Howard E. Evans

INTRODUCTION

The species of *Pristocera* are among the better known and more commonly collected Bethylidae. They are relatively large, and the males are often taken by sweeping low vegetation in fields and open woodlands. The females are less commonly collected, since they are apterous and closely associated with the soil. The larvae develop as external parasites of wireworms (Elateridae) and are among the few known parasites of those insects.

There has been no treatment of the North American species of *Pristocera* since the early and very inadequate studies of Ashmead (1893) and Kieffer (1914). The Neotropical species were covered in part by Cameron (1888) and by Kieffer (1914), but these authors made several generic misassignments. The present treatment does not pretend to be definitive, but it may at least serve to point out that the genus is larger than had been appreciated, and that much further collecting is needed in the tropics and subtropics.

Pristocera is in many ways one of the most tiphiid-like of the Bethylidae: the males have a relatively full venation and the general facies of Tiphiinae, while the females are apterous like those of several other subfamilies of Tiphiidae. However, since most female Bethylidae are winged and much like the males, it is difficult to believe that the family was derived from a group with wingless females. Reid (1941) finds the thorax of wingless female Bethylidae such as *Pristocera* to be basically similar to that of certain Tiphiidae. Doubtless there has been parallel evolution in the two groups, with genera which attack subterranean or cryptobiotic larvae bearing much resemblance.

ACKNOWLEDGMENTS AND SOURCES OF MATERIAL

This revision would have been impossible without the cooperation of many institutions and individuals. The following list is meant to serve as an acknowledgment of each as well as an

[1] Acknowledgment is made to the Permanent Science Fund of the American Academy of Arts and Sciences, a grant from which made it possible for the author to travel to London to study type specimens in the British Museum (Natural History).

indication of the abbreviation by which each is designated in the text:

Academy of Natural Sciences of Philadelphia (ANSP)
American Museum of Natural History, New York (AMNH)
British Museum (Natural History), London (BMNH)
California Academy of Sciences, San Francisco (CAS)
California Insect Survey, Berkeley (CIS)
Canadian National Collections, Ottawa (CNC)
Carnegie Museum, Pittsburgh, Pa. (CM)
Cornell University, Ithaca, N. Y. (CU)
Florida State Plant Board, Gainesville (FSPB)
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Kansas University, Lawrence (KU)
Kansas State University, Manhattan (KSU)
K. V. Krombein Collection, Arlington, Va. (KVK)
Museum of Comparative Zoology, Cambridge, Mass. (MCZ)
University of Arizona, Tucson (UA)
University of California, Davis (UCD)
United States National Museum, Washington (USNM)

BIOLOGY OF THE GENUS

Pristocera armifera (Say), a common species throughout eastern United States, is the only American species to have been studied. Hyslop (1916) found a larva feeding on the ventral surface of the abdomen of a larva of *Limonius agonus* (Say) (Elateridae) near Brattleboro, Vermont. This wireworm was found about six inches deep in a corn field, where the wireworms were doing serious damage. The parasite larva reduced its host to an empty skin and then attached itself (in a rearing tin) to a second wireworm "by inserting the mouth parts in the sternum of the third abdominal segment and lay appressed to the ventron of the host with the head directed caudad" (see Hyslop's figure 2). The parasite also consumed most of the second host and then spun a silken cocoon 9 mm. long and 3.5 mm. in diameter. Thirty-three days later (on August 30) a male *Pristocera armifera* emerged from this cocoon. Hayes (1927) repeated Hyslop's observations in Kansas, again obtaining an adult during the same season; in this case the wireworm was tentatively identified as *Aeolus elegans* (Fabr.). Hyslop's specimen is in the collection of the USNM, and I have confirmed its identity as *Pristocera*

armifera. There is also a specimen of this species in the collection of Robert Fouts from East Windsor Hill, Conn., labeled "parasite of *Limonius* larva (H. L. Parker)."

Miwa and Sonan (1935) reared *Pristocera formosana* Miwa and Sonan from the elaterids *Melanotus tamsuyensis* Bates and *Agonischius obscuripes* Gyllenhal in Formosa. Their paper is in Japanese and I have not read it. Yasumatsu (1955), in his review of the Japanese species, records *P. japonica* from an "unknown elaterid larva." There is a good possibility that all species of *Pristocera* will be found to attack elaterid larvae.

Yasumatsu reports a pair of *P. formosana* taken "while they were flying in copula." I have seen four different pairs of North American *Pristocera* taken in copula (three different species); one of these is labeled "on window," another "on wooden wall in old sawmill." Apparently the male flies with the female in somewhat the manner of certain Tiphiidae and Mutillidae, but more data are needed on this point. Since I have seen about 500 male *Pristocera* and only four taken with females, I cannot believe that they remain together in flight very long.

STRUCTURE AND TERMINOLOGY

Because of the pronounced sexual dimorphism in this genus, the sexes are treated separately both here and in the keys and descriptions. The abbreviations used in the text are listed at the end of this section.

Males. — Males are fully winged and usually black in color; they vary in length from about 4 to 14 mm., individual species often exhibiting much size variation. In the descriptions, length of the fore wing (LFW) is employed, as it can be measured more accurately than body length. The mandibles have either four or five teeth; these are numbered one to five starting with the apical (outermost) tooth. The clypeus is short, broadly truncate or somewhat emarginate, and has a median carina. The eyes have minute setae and in a few species long, conspicuous setae; the eyes usually converge somewhat below. Length of the head (LH) is measured from the vertex crest to the median apical margin of the clypeus, width of the head (WH) at the maximum point, including the eyes. Width of the front (WF) is measured at its minimum point, usually toward the bottom of the eyes. Height of the eye (HE) is measured at its maximum in lateral aspect. The width of the ocellar triangle (WOT) is measured across and including the posterior ocelli.

while the ocello-ocular line (OOL) is measured from a lateral ocellus to the nearest eye margin. The ocelli vary little in size within the genus, the species being largely diurnal fliers. The occipital carina is complete although situated well back of the vertex crest. The antennae are elongate, 13-segmented; measurements are given for the third and eleventh segments only, as these are typical of the basal and apical flagellar segments. The antennae are typically filiform, but they may be weakly serrate or moniliform (Figs. 48-51).

The term thorax is employed to mean the functional thorax or alitrunk. The pronotum has an anterior collar followed by a more or less vertical anterior face and finally a dorsal, posterior portion called the disc. The shape and sculpturing of the pronotal disc are of much importance in species discrimination. In all species there is a transverse impression paralleling the posterior margin of the pronotum. The mesonotum has the notauli strong and complete or nearly so, as well as a strong transverse groove at the base of the scutellum. The propodeum has a dorsal portion called the disc, a sloping posterior declivity, and vertical sides. The disc has a basal, more or less triangular portion, called simply the basal triangle, which is usually marked off by a depression or carina, sometimes both. The disc has a median carina which usually becomes indistinct shortly before reaching the declivity; there may also be a transverse carina at the edge of or slightly down on the declivity. The posterior part of the propodeal disc is covered with sculpturing. The mesopleurum is punctate and has a small callus above, which is subtended by a depression and which leads anteriorly into a longitudinal carina. The tarsal claws have a basal swelling and two additional teeth, such that they are indistinctly tridentate or trifid (Figs. 55-60). The wing venation is typical of the tribe, with the discoidal vein of the fore wing always being present at least in some measure, the discoidal cell more or less closed in most species.

The genitalia are of striking form and show excellent specific differences (Figs. 1-4, 9-31, 36-41). The most lateral, apical structures are the parameres. Mesad of these are the volsellae, which terminate in a rigid digitus (which generally fits into a concavity in the paramere) and a more mesal, apparently movable and somewhat knobbed cuspis. The aedoeagus is of very complex structure and can scarcely be described or figured in all its intricate detail; it is conveniently considered to consist of three sets of "valves" (see, for example, Fig. 4). The ventral valves are the shortest and are of simple structure. The middle

valves usually extend beyond the ventral valves and may be blunt apically (Fig. 11), acute (Fig. 12), and sometimes very complicated (Fig. 29). The third set of valves, the dorsal valves, extend beyond the middle valves and form the apical parts of the aedoeagus; sometimes there are two lobes, which may be connected (Fig. 4) or unconnected (Fig. 11), at other times there are four lobes (Fig. 10) or even more (Fig. 28). All in all, the genitalia provide an abundance of characters of importance, and it is a good procedure to examine the genitalia routinely in this genus.

Females. — Females are completely apterous and without tegulae, and show corresponding reductions in the thorax as well as adaptations for digging in the soil. Reid (1941) has discussed and figured the thorax of the related genus *Mangesia,* from Africa. The females vary in length from about 4 to 9 mm., with individuals of a given species showing much size variation and the females running smaller than the males. The eyes are small but have at least several facets and may have more than can be conveniently counted (more than 50). The known American species all have 4-toothed mandibles. The clypeus is carinate medially, the antennae short and usually somewhat incrassate. The head is slightly longer than wide. Length of the head (LH) is measured from the median apex of the clypeus to the median crest of the vertex, in full front view; width of the head (WH) is measured at the mid-point of LH. The occipital carina is obsolescent dorsally. Ocelli are absent.

Length of the thorax (LT) is measured from the anterior end of the pronotal disc (omitting the collar) to the posterior end of the propodeum. The pronotal disc is longer than wide; its width is measured at its maximum, which is at or near the posterior margin. The mesonotum is measured exclusive of the anterior, transversely depressed portion. The propodeum extends around each side of the mesonotum to about half the length of the latter; behind the mesonotum it is strongly constricted and then once again expanded. The total length of the propodeum is measured from the anterior end of these projections to the point of articulation with the abdomen (gaster). The minimum and maximum widths of the propodeum are also measured and compared. The disc of the propodeum is usually smooth and polished and is margined laterally by a delicate carina. The mesopleura are large and form the widest portion of the thorax. The femora are compressed, the middle tibiae strongly spinose. The claws have a single, weak tooth.

The following is a summary of the abbreviations used in the text:

HE: height of eye (maximum, lateral view)
LFW: length of fore wing
LH: length of head (including clypeus, not mouthparts)
LT: length of thorax (excluding collar but including propodeum)
OOL: ocello-ocular line
WF: width of front (at minimum point)
WH: width of head
WOT: width of ocellar triangle (including lateral ocelli)
X: times

TAXONOMY OF AMERICAN SPECIES

The American species of *Pristocera* form a somewhat heterogeneous lot, and cut across several of the characters established by Yasumatsu (1955) for separating the subgenera *Pristocera* and *Neopristocera* Yasumatsu. All of them do, however, lack the deeply divided subgenital plate of the males of *Pristocera sensu stricto,* and the male genitalia are consistently different from those of the species of *Pristocera sensu stricto* that I have examined. Although the females of the two groups cannot presently be distinguished, I am inclined to recognize the two subgenera. However, the name *Acrepyris* Kieffer applies to the same group as *Neopristocera* Yasumatsu and has priority. All of the American species are assignable to the subgenus *Acrepyris,* although some of them (particularly *sinaloa* n. sp.) come very close to *Pristocera sensu stricto* in all respects other than the male terminalia. The subgenus *Pristocera* is treated briefly below in order to clarify its differences from *Acrepyris.*

Nineteen American species can currently be assigned to *Pristocera* (*Acrepyris*), though there may still be undiscovered species, especially in Central America. Several species described in *Pristocera* or referred to *Pristocera* by Kieffer (1914) do not properly belong there. I have seen the types of most of these species and hope to treat them in future papers. In the meantime I shall merely list these species and indicate the genera to which they belong. Species here reassigned to *Pseudisobrachium* Kieffer are: *burchellana* Westwood (Brazil), *coxalis* Cameron (Panama), *crassicornis* Westwood (Brazil), *haemorrhoidalis* Westwood (Brazil), and *rufiventris* Kieffer (Brazil). Species here reassigned to *Apencsia* Westwood are: *columbana* Westwood

(Columbia), *fulvicollis* Westwood (Brazil), *microchela* Kieffer (Mexico), *photophila* Ogloblin (Argentina), and *punctatus* Cameron (Mexico).

Key to Subgenera of Pristocera (Males)

Subgenital plate divided all the way to its base (Fig. 7); genitalia with the digiti in the form of broad, truncate plates, aedoeagus slender and tapering, its parts closely consolidated (Fig. 1); flagellum with short, subrecumbent setulae and also with some erect setae which stand out above them; claws with middle ray close to outer ray and subparallel to it (Fig. 55) ..... *Pristocera* Klug

Subgenital plate entire, at most weakly emarginate (Figs. 5, 6, 8); genitalia with the digiti in the form of slender, curved rods, aedoeagus complex, with three sets of valves which are not closely consolidated (Figs 2-4, 9-31, 36-41); flagellum with suberect, bristling setulae, most species without erect setae which stand above the pubescence; claws variable (Figs. 56-60) ..... *Acrepyris* Kieffer

Subgenus PRISTOCERA Klug

Pristocera Klug, 1808, Mag. Gesell. Naturf. Freunde Berlin, 2: 49. —Kieffer, 1905, *In* André, Spec. Hymen. Eur. Alger., 9: 287. —Kieffer, 1914, Das Tierreich, 41: 453-470 (key to spp. of world). —Yasumatsu, 1955, Jour. Fac. Agri., Kyushu Univ., 10: 233-249 (Japanese species). —Benoit, 1957, Explor. Parc Nat. Albert, Mission DeWitte, fasc. 88, pp. 46-55 (Central African spp.).

Type species. — *Bethylus depressus* Fabricius, 1804, Syst. Piez., p. 237 (monobasic).

Subgeneric characters (males). — Antennae short or of moderate length, flagellum with subrecumbent pubescence and also with at least a few longer, erect setulae; eyes glabrous; pronotum variable, with or without transverse rugosities, with or without a transverse impression paralleling the posterior margin; propodeum without a transverse carina margining the disc behind; claws bifid or indistinctly trifid, somewhat variable but always with the tooth elongate and more or less parallel to the outer ray; subgenital plate deeply divided to the base; parameres of genitalia rather elaborately modified, in most species quite long; digiti broad and truncate apically; aedoeagus relatively slender and with the parts closely consolidated (Figs. 1, 7, 55).

Remarks. — This subgenus occurs in the Palearctic, Oriental, and Ethiopian regions. I have studied the type species and several unidentified African and Oriental species. Benoit (1957) has provided descriptions and illustrations of the propodeum

and terminalia of several African species. I have seen females of *depressa* and two other species, but like Yasumatsu (1955) I can find no characters for separating them from females of the subgenus *Acrepyris*. This subgenus does not occur in the Western Hemisphere and will not be treated further here.

Subgenus ACREPYRIS Kieffer

Acrepyris Kieffer, 1905, *In* André, Spec. Hymen. Eur. Alger., 9: 249. —Kieffer, 1914, Das Tierreich, 41: 236, 418.

Neopristocera Yasumatsu, 1955, Jour. Fac. Agri. Kyushu Univ., 10: 248 (proposed as subgenus of *Pristocera* with *P. japonica* Yasumatsu as type species). New synonymy.

Type species. — *Epyris reticulatus* Kieffer 1904 (= *Pristocera armifera* Say, 1828) (monobasic and original designation).

Subgeneric characters (males). — Antennae rather long, filiform, submoniliform, or weakly serrate, flagellum densely clothed with erect or suberect pubescence which may be short or long, one species with erect setae which stand out above this pubescence; eyes with or without hairs; pronotum smooth or transversely rugose, always with a transverse impression at or paralleling posterior margin; propodeum with or without a transverse carina margining the disc behind; claws with a broad, weak basal tooth and two additional rays which may be well separated or close together and subparallel, the inner ray short or rather long; subgenital plate simple, undivided, its apical margin rounded, truncate, or emarginate; genitalia with parameres short or fairly long, variously lobed or excavated but not modified as in *Pristocera sensu stricto;* digiti slender and curved; aedoeagus with three sets of valves, ventral valves in the form of slender plates, middle valves blunt or acute, exceeding ventral valves except in *armifera*, dorsal valves lobate or greatly expanded apically (Figs. 2-6, 8-54, 56-60).

Remarks. — This subgenus occurs throughout temperate and tropical North and Central America and also occurs in Japan, the Philippines, and Java. I have seen no specimens from the West Indies or from South America, although two species are known from Panama and doubtless enter northwestern South America. Several South American species described in *Pristocera* actually belong elsewhere (see list on a previous page). I would expect *Acrepyris* to have evolved in North or Central America during the Tertiary, when this area was cut off from South

America. The ancestral stock was doubtless *Apencsia*, a genus well represented in this area, some members of which approach *Acrepyris* rather closely. An early invasion from North America to Asia may have given rise to the more highly evolved subgenus *Pristocera*, while a much later invasion may have resulted in the east Asian species of *Acrepyris*. The fact that the Asian species of *Acrepyris* are few in number and rather homogeneous in structure suggests that the group may have had its origin in North or Central America, where there are many more species and much more structural diversity.

I have studied specimens of *japonica*, the type species of *Neopristocera*, and find this species very similar to the American forms. The genitalia of this species are shown in Figure 3; it will be noted that the aedoeagus and parameres are shaped differently than in any of our species, but the differences are not striking. The African species placed by Benoit (1957) in *Neopristocera* are not congeneric with *japonica*, *armifera*, and their allies. The synonymy of *reticulatus* Kieffer, type species of *Acrepyris*, with the common North American species *armifera* Say is discussed under that species.

There are two specimens of *P. japonica* in the U. S. National Museum from Moorestown, New Jersey, labeled "from Tiphia 6-6, ship't 5-6-34." Doubtless these were brought in during the importations of parasites of the Japanese beetle. There is no evidence that this species is established in the United States, and it is not included in the key below.

Despite the fact that the species of *Pristocera* (*Acrepyris*) are the largest in size of American Bethylidae, the genus is a difficult one. The most reliable characters are to be found in the male genitalia, and persons encountering difficulties in the key which follows are advised to examine the genitalia and compare them with the figures. The tarsal claws and shape and sculpture of the pronotum provide important specific characters, but these differences are not always easy to express in words; furthermore, a certain amount of intraspecific variation occurs in both characters. Unfortunately, the nineteen American species do not fall into clear-cut species groups. There are certain species centering around the common eastern species *armifera* (species 1-8), others centering around the hairy-eyed species *hyalina* (species 11-17), but the limits of these groups are ill-defined and there are several species not closely allied to either group or to each other. The females of only five of the nineteen species are known.

Key to species of Pristocera (Acrepyris) in the Americas

Males

1. Claws with inner ray (or tooth) well separated from outer ray and not larger than outer ray (if somewhat thicker then abruptly truncate and much shorter) (Figs. 57-60); aedoeagus of variable form but with the ventral valves elongate and overlapping the middle valves, the dorsal valves not abruptly and broadly expanded apically as below (Figs. 2, 4, 9-12, 18-21, 29-31, 36-41) 2

   Claws with inner ray arising very close to outer ray, subparallel to it and actually larger than outer ray (Fig. 56); aedoeagus of unusual form, the ventral and middle valves both very short and not overlapping, the dorsal valves remarkably expanded apically (Figs. 27, 28) 18

2. Mandibles unusually straight, the lower margin but little curved, the five teeth in a strongly oblique series (Fig. 54); basal flagellar segments conspicuously serrate in profile (Fig. 48); apical lobes of aedoeagus somewhat boot-shaped (Fig. 12) (Carolinas and Florida to New Mexico) . . . . . 10. *atra* Klug

   Mandibles more distinctly curved and with the four or five teeth in a less strongly oblique series (Figs. 32-35); basal flagellar segments not or indistinctly serrate in profile (Figs. 49-51); aedoeagus not as above 3

3. Propodeum long for the genus, the dorsal surface about as long as wide; propodeum polished and weakly sculptured behind the basal triangle; aedoeagus of unusual form in that the middle valves are hooked dorsad, the dorsal valves hooked ventrad, closely embracing the middle valves (Figs. 2, 31); size small for the genus (LFW 3.7-5.0 mm.) (Guerrero, Mexico) . . . . . 7. *oriplana* Kieffer

   Propodeum short, the dorsal surface considerably wider than long (at least 1.1 X as wide as long); propodeum rather coarsely sculptured; aedoeagus not as described above; size variable (LFW 3.2-9.0 mm.) 4

4. Pronotum with at least a few more or less distinct transverse rugae, and with a generally smaller number of setigerous punctures than below; eyes glabrous or with minute setae; aedoeagus with the middle valves blunt apically (Figs. 4, 9, 11, 29, 40), or if acute somewhat separated (Figs. 10, 41) 5

   Pronotum with smooth contours except transversely depressed posteriorly, with a large number of setigerous punctures which tend to be somewhat transverse, but without transverse rugae; eyes with short to fairly long setae; aedoeagus with the middle valves acuminate, closely associated apically and forming a sharp wedge between the somewhat bulbous apical lobes of the dorsal valves (Figs. 18-21, 30, 36-38) 11

5. Wings with a yellowish tinge and prominently banded; parameres of genitalia broadly, abruptly truncate apically (Fig. 4); antennae

light yellowish-brown and legs in large part of this color; apical half of abdomen rufous (Panama and Costa Rica) ..... 8. *erythropoda* (Cameron)

Wings hyaline or lightly clouded, not strongly banded; parameres longer than above, not broadly truncate apically; color rarely as above 6

6. Pronotum weakly and irregularly transversely rugulose, without a transverse ridge which stands out prominently above the rugae; antennae very long and slender, segment eleven at least 3.5 X as long as thick 7

Pronotum with a transverse ridge before the posterior depression which stands out strongly above the rugae; antennae generally shorter, segment eleven at most about 3 X as long as thick 10

7. Mesopleurum strongly polished and with small, well separated punctures; apical lobes of aedoeagus directed somewhat laterad (Figs. 29, 41) 8

Mesopleurum with large, subcontiguous punctures; apical lobes of aedoeagus directed mesad (Figs. 9, 40) 9

8. Punctures of mesopleurum very small, separated by more than their own diameters; basal triangle of propodeum large, bordered by carinae and a shallow depression; apical lobes of aedoeagus large, close together, middle valves acute, simple (Fig. 41) (Wyoming and Utah to California) ..... 3. *californica* n. sp.

Punctures of mesopleurum larger, separated by mostly less than their own diameters; basal triangle of propodeum indistinct; apical lobes of aedoeagus slender, well separated, middle valves blunt, of complex structure (Fig. 29) (central Mexico) ..... 6. *otomi* n. sp.

9. Pronotum rather elongate and with sides of disc weakly concave as seen from above (Fig. 43); pubescence of flagellum unusually coarse, setulae of antennal segment eleven two-thirds as long as width of segment; aedoeagus with middle valves extending beyond apex of ventral valves, apical lobes of dorsal valves thick, strongly reflexed (Fig. 40) (Carolinas, Florida, Kansas) ..... 2. *fraterna* n. sp.

Pronotum shorter and with sides nearly straight (Fig. 42); setulae of antennal segment eleven generally about half as long as width of segment; aedoeagus with middle valves not extending beyond apex of ventral valves, apical lobes of dorsal valves flap-like, directed mesad but not downward (Fig. 9) (eastern United States, west to Dakotas, Colorado, and Texas) ..... 1. *armifera* (Say)

10. Collar and anterior face of pronotum very smooth and polished; transverse ridge of pronotum very abruptly declivous to posterior impression; apical lobes of aedoeagus very slender and extending far beyond remainder of aedoeagus (Fig. 11) (Arkansas) ..... 5. *bridwelli* n. sp.

Collar and anterior face of pronotum with some sculpturing, not as strongly or extensively polished as above, transverse ridge also less sharply set off from posterior depression than above; apical lobes

of aedoeagus extending only slightly beyond other structures, connected by a membrane (Figs. 10, 39) (Texas and Arizona to Oaxaca) ..... 4. *cockerelli* n. sp.

11. Pronotum of moderate length, disc somewhat roundly produced anteriorly, generally measuring more than half as long as mesoscutum along midline (Fig. 44); apical lobes of aedoeagus simple, moderately bulbous (Figs. 21, 36-38); claws with the inner ray (tooth) variable, but never broad and abruptly truncate (Figs. 59, 60) 12

Pronotum very short, transverse, anterior margin of disc forming a rather even arc, disc generally measuring less than half as long as mesoscutum along midline (Fig. 45-47); either with inner ray of claws abruptly truncate (Fig. 58) *or* with the apical lobes of the aedoeagus strongly bulbous (Fig. 20) or variously modified (Figs. 18, 30) 15

12. Flagellar pubescence very long, longest setulae of antennal segment eleven about .8 as long as width of segment; eyes with only short setae; apical lobes of aedoeagus somewhat thicker than below (Fig. 21) (Guatemala) ..... 14. *nebulosa* n. sp.

Flagellar pubescence short or moderately long, setulae of antennal segment eleven not over half as long as width of segment; eyes (except in rubbed specimens) with some fairly long setae on upper part; apical lobes of aedoeagus more slender than above (Figs. 36-38) 13

13. Propodeum with sculpturing rather irregular, transverse striations indistinct; setulae of antennal segment eleven about .4 as long as width of segment; aedoeagus with middle valves extending three-fourths the distance from apex of ventral valves to apex of dorsal valves (Fig. 37) (Morelos and state of Mexico) ..... 13. *tenochca* n. sp.

Propodeum with strong, rather regular transverse striations behind; setulae of antennal segment eleven not more than .3 as long as width of segment; aedoeagus with middle valves reaching only about half the distance from apex of ventral valves to apex of dorsal valves, not extending between the apical lobes of the latter (Figs. 36, 38) 14

14. Clypeus not emarginate; apical lobes of aedoeagus very slender (Fig. 38) (San Luis Potosi, Mexico) ..... 12. *intermedia* n. sp.

Clypeus with a broadly V-shaped apical emargination; apical lobes of aedoeagus moderately thick (Fig. 36) (southern half of Mexico) ..... 15. *varidens* (Cameron)

15. Eyes with only very short setae; inner ray of claws sloping outward, subparallel to outer ray, so that the claws are somewhat bifid (as in Figs. 55, 58) (central Mexico, Guatemala) 16

Eyes with some rather long setae above (except in rubbed specimens); claws dentate, tooth short and erect, well separated from outer ray (as in Fig. 60) (southern United States and northern Mexico) 17

16. Inner ray of claws acute; setulae of antennal segment eleven .5 X as long as width of segment; parameres simple (Fig. 22); apex of dorsal valves of aedoeagus deflected ventrad (Fig. 30) (Orizaba, Mexico) ..... 9. *orizabae* (Cameron)

Inner ray of claws broad and truncate (Fig. 58); setulae of antennal segment eleven .25 X as long as width of segment; parameres excavated and lobed on margins (Fig. 26); apex of dorsal valves of aedoeagus not deflected ventrad (Fig. 19) (Guatemala) ..... 17. *rugifrons* (Cameron)

17. Anterior margin of clypeus more narrowly produced than below, median portion truncate or weakly concave; setulae of antennal segment eleven .2-.3 X as long as width of segment; wings hyaline or weakly infuscated; apical lobes of aedoeagus in the form of twisted flaps (Fig. 18) (Louisiana, Texas, New Mexico) ..... 11. *hyalina* Brues

Anterior margin of clypeus broadly produced and with a broadly V-shaped anterior emargination; antennal pubescence very fine, almost velvety, setulae of segment eleven about .15 X as long as width of segment; wings of most specimens heavily infuscated except apically; apical lobes of aedoeagus strongly bulbous (Fig. 20) (Chihuahua and Arizona) ..... 16. *chihuahua* n. sp.

18. Flagellar pubescence bristling and of moderate length, flagellum without erect setae which extend above the pubescence; middle and hind tarsi whitish basally; median apical lobes of aedoeagus exceeding lateral lobes (Fig. 27) (Panama to Tabasco, Mexico) ..... 18. *palliditarsis* (Cameron)

Flagellar pubescence short, basal segments with some erect setae which extend well above pubescence; middle and hind tarsi light yellowish-brown; lateral apical lobes of aedoeagus exceeding median lobes (Fig. 28) (Sinaloa, Mexico) ..... 19. *sinaloa* n. sp.

Females

1. Mandibles slender, lower margin turned somewhat downward, teeth in a strongly oblique series (Fig. 53); propodeum unusually long and weakly constricted (maximum width about twice minimum width); pronotal disc flat, long, gradually narrowed anteriorly; hind tibiae densely clothed with short, thick setae (Texas to Florida and Carolinas) ..... 10. *atra* Klug

Mandibles wider, lower margin not curved downward, teeth in a less strongly oblique series (Fig. 52); propodeum less elongate and more constricted (maximum width 2.3-3.3 minimum width); pronotal disc less elongate, sides not convergent as above; hind tibiae with only some weak setae 2

2. Eyes small, only slightly higher than wide, each with only about 15 facets, HE about .12 X WH; sides of head weakly convergent to near posterior margin (Texas to Arizona and to Oaxaca) ..... 4. *cockerelli* n. sp.

Eyes larger, much higher than wide, each with 50 or more facets, HE about .16-.18 X WH 3

3. Head strongly polished and non-alutaceous; LH about 1.36 X WH; propodeum about 1.9 X as long as maximum width (Carolinas, Florida, Kansas) ..... 2. *fraterna* n. sp.

Head polished but (on close inspection) weakly and regularly alutaceous; LH 1.14-1.32 X WH; propodeum usually about 2.1 X as long as maximum width 4

4. Punctures of head rather small and shallow, separated by (for the most part) about their own diameters (absent medially); WH 1.14 X LH, sides of head strongly bulging; propodeum punctate over most of surface (Arkansas) . . . . . 5. *bridwelli* n. sp.

Punctures of head strong, for the most part separated by less than their own diameters and showing some tendency to form longitudinal series (absent medially); sides of head subparallel or weakly bulging, LH 1.18-1.32 X WH; propodeum punctate only on extreme sides (eastern United States) . . . . . 1. *armifera* (Say)

1. Pristocera (Acrepyris) armifera (Say)

Bethylus armiferus Say, 1828, Contr. Maclurian Lyceum Phila., 1: 80. [Type: ♂, INDIANA (destroyed)].

Scleroderma thoracica Westwood, 1839, Trans. Ent. Soc. London, (1)2: 167. [Type: ♀, "AMERICA BOREALI" (? no longer extant)]. Placed in synonymy with *atra* by Ashmead, 1893 (see under "Remarks" below).

Scleroderma contracta Westwood, 1839, Trans. Ent. Soc. London, (1)2: 169. [Type: ♀, "CAROLINA" (? no longer extant)]. Synonymy by Ashmead, 1893, who had seen the type.

Epyris laeviventris Cresson, 1872, Trans. Amer. Ent. Soc., 4: 193 [Type: ♂, TEXAS (Belfrage) (ANSP no. 1829)]. Placed in synonymy by Ashmead, 1893.

Pristocera armifera Ashmead, 1893, Bull. U.S. Nat. Mus., 4: 34-35. —Kieffer, 1914, Das Tierreich, 41: 466. —Hyslop, 1916, Proc. Ent. Soc. Wash., 18: 169-170, pl. XI (biology). —Hayes, 1927, Proc. Ent. Soc. Wash., 29: 20-22 (biology).

Epyris reticulatus Kieffer, 1904, Ark. Zool., 1: 527. [Type: ♂, TEXAS (Belfrage) (Naturhist. Riksmus. Stockholm, no. 229)]. New synonymy.

Acrepyris reticulatus Kieffer, 1905, *In* André, Spec. Hymen, Eur. Alger., 9: 249. Made type of new genus *Acrepyris*. —Kieffer, 1914, Das Tierreich, 41: 418-419.

Plesiotype. —♂, INDIANA: New Harmony, 2 Sept. 1886 (S. A. Forbes) [INHS].

Description of plesiotype. — Length 8 mm., LFW 5.4 mm. Head and thorax black, flagellum, legs, and abdomen dark reddish brown; wings subhyaline, veins and stigma brown. Mandibles with five teeth, fourth tooth somewhat weaker than the others, lower margin strongly arched (about as in Fig. 32). Clypeus truncate, median keel strong, arched in profile. Antennae elongate, first four segments in a ratio of about 22:4:16:16, segment three 2.2 X as long as thick, segment eleven 4 X as

long as thick; pubescence pale, suberect, setulae of segment eleven about .4 as long as thickness of segment; basal flagellar segments weakly depressed, flagellar segments barely thickened apically (about as in Fig. 50). Eyes with only weak, short hairs. Surface of head shining; front, vertex, and temples covered with very large punctures which are so crowded that the space between them is reduced to a network of ridges. Head about as wide as long; WF .68 X WH, 1.6 X HE; ocelli in a right triangle, WOT .9 X OOL. Pronotum with anterior slope perpendicular to collar and to disc; disc with sides evenly expanded posteriorly (Fig. 42), sharply margined anteriorly and wholly covered with weak, irregular transverse rugae and transversely elongate punctures; setae pale, short, not especially dense; sides of pronotum striate. Mesonotum smooth and polished, with strong, well separated punctures. Propodeal disc with several irregular longitudinal carinae basally, the median one extending nearly to posterior margin; basal triangle large, rather weakly defined; disc otherwise with irregular transverse striae except reticulo-punctate laterally and posteriorly like posterior slope; disc separated from posterior slope by an arching, rather weakly defined carina. Mesopleura shining, with large punctures which are separated by less than their own diameters, callus weakly punctate. Claws dentate, tooth erect, well separated from outer ray (Fig. 60). Fore wing with radial vein short, reaching only about half the distance from its base to wing tip; discoidal vein well developed for a short distance, then fading out; discoidal cell faintly outlined. Abdomen shining, somewhat depressed. Subgenital plate arcuately emarginate apically (Fig. 5). Genitalia as shown in Figure 9; parameres subtriangular apically; middle valves of aedoeagus not exceeding the ventral valves and therefore not readily visible; apex of dorsal valves in form of thin, rounded lobes which are directed ventrad and mesad.

Males examined. — I have examined 426 males, from the following localities: VERMONT: Newfane; NEW HAMPSHIRE: Hampton; MASSACHUSETTS: Forest Hills, Holliston; RHODE ISLAND: Westerly; CONNECTICUT: E. Hartford, Meriden, Manchester, Canaan, East Windsor Hill, S. Kent, Stonington; NEW YORK: Ithaca, Poughkeepsie, White Lake, New Baltimore, New York City, Wyandanch, L.I., Sea Cliff, L.I., Cold Spring Harbor, L.I., Farmingdale, L.I.; NEW JERSEY: Haddon Heights, Adele, Lakewood, Ramsay, Laurelton, Riverton, Sea Isle City, Wildwood, Moorestown, Brown's Mills, Princeton; PENNSYLVANIA: Dupont, Harrisburg, Philadelphia,

Swarthmore, Roxboro, Pittsburgh; MARYLAND: Bowie, Takoma Park, Rockville, Plummer's Island, Cumberland, Kenwood Beach, Silver Springs, Cabin John, Beltsville; DISTRICT OF COLUMBIA: Washington; VIRGINIA: Falls Church, Dunn Loring, Chain Bridge, Vienna, Glencarlyn, Galax, Portsmouth, Virginia Beach, Charlottesville, Shenandoah Nat. Park, Nelson Co., Smyth Co.; WEST VIRGINIA: Bolivar, Lewis Co.; NORTH CAROLINA: Kitty Hawk, Robertsonville, Andrews, New River, Wake Co., So. Pines, Black Mts., Tuckasegee, Macon Co., Yancey Co., Highlands, Garland, Cedar Mt., Flat Rock; SOUTH CAROLINA: Kingstree, Georgetown, Clemson, Table Rock, Greenville, McClellanville, Walhalla, Greenwood; GEORGIA: Atlanta, Athens, Fort Mt., Ft. Gordon, Blood Mt., Tifton, Thomas Mills, Toccoa, Waycross, Millwood, Adel, Okefenokee Swamp, Prattsburg, Decatur Co., Pine Mt., Hiawassee; FLORIDA: Hilliard, Jacksonville, Alachua Co., Lakeland, Levi Co., Williston, Suwanee Springs, Hillsboro Co., Orlando, Sanford, Lake Placid, Hudson, Capron, Ft. George, Miami, Biscayne Bay, Glades Co., Long Key, Big Pine Key, Upper Matecumba Key; ALABAMA: Coleta, Chilton Co., Sheffield, Kushla, Mobile; MISSISSIPPI: Natchez; LOUISIANA: Tallulah; TENNESSEE: Monteagle, Chattanooga; OHIO: Lawrence Co.; MICHIGAN: Ann Arbor, Livingston Co.; INDIANA: Jackson Co., New Harmony; ILLINOIS: Beach, Jonesboro, Fountain Bluff, Carbondale, Aldridge, DuBois, Algonquin, Forest Park, Urbana, Rockford; IOWA: Dubuque, Sioux City, Ames; SOUTH DAKOTA: Phillip, Fairfax; NEBRASKA: Valentine, Dunning; MISSOURI: St. Louis, Monroe City; KANSAS: Douglas Co., Baldwin, Ottawa Co., Riley Co., Onaga, Silver Lake, Leon, Sedgwick Co., Reno Co., Bourbon Co., Republic Co., Hays; COLORADO: Wray; TEXAS: Galveston, Denison, Sealy, Port Isabel. Dates of capture, in the northern states, range from June to October, with August the most common month; Florida dates range from April to December.

Variation in males. — The smallest male examined measures 4.5 mm., LFW 3.2 mm.; the largest measures 9 mm., LFW 6.3 mm. In many specimens the legs and abdomen are black or nearly so. In some specimens the fore wing is distinctly clouded, especially in and about the radial cell. Neither size nor wing color appear to vary geographically, specimens from one locality often showing much variation in each. In most specimens the length of the antennae approximates that of the plesiotype, but

specimens from the southwestern parts of the range have consistently shorter antennae. For example, in the series from near Sealy, Texas, the length of antennal segment three averages 2.0 X as long as thick, while in a single specimen from Cameron Co., Texas, this segment measures 1.7 X as long as thick. In some specimens minor variation in sculpture can be noted, and in some the vertex is unusually strongly produced above the eye tops. The mandibles always have five teeth, but in some specimens the fourth tooth is small, more as in Figure 33. The subgenital plate is sometimes less deeply emarginate than figured. In some specimens the parameres are subtruncate apically, though seldom as distinctly so as in the species which follows; minor variation can be noted in the shape of the apical parts of the ventral and inner valves of the aedoeagus.

Plesiallotype. — ♀, INDIANA: Lafayette, 11 April 1933, bluegrass sod (H. R. Painter) [USNM].

Description of plesiallotype. — Length 6.3 mm., LH 1.37 mm., LT 2.3 mm. Body uniformly bright castaneous; legs and apices of antennae bright yellowish-brown. Mandibles with four teeth, as shown in Figure 52. Clypeus broadly rounded apically and with a small median notch; median carina arched in profile. Head shining, weakly and uniformly alutaceous, with strong punctures except along median line; punctures separated for the most part by somewhat less than their own diameters, showing some tendency to form longitudinal series. LH 1.25 X WH, sides of head subparallel to near posterior margin, where they converge arcuately to a straight vertex. Eye higher than wide, with a large number of facets (more than 50); HE .18 X WH, slightly greater than maximum width of flagellum. Antennae slightly thickened apically, segment eleven about .9 as long as thick. Pronotal disc 1.15 X as long as wide, shining and non-alutaceous, punctures strong, well separated, absent along median line. Disc of mesonotum about .7 X as long as wide, shining and with a few small punctures. Propodeum 2.1 X as long as its maximum width, 5 X as long as its minimum width, maximum width 2.5 X minimum width; surface strongly shining, non-alutaceous, with a few weak punctures on sides. Femora and tibiae moderately compressed, middle tibia with about 20 strong spines, hind tibia with short, weak hairs.

Females examined. — I have examined 36 females, from the following localities: MASSACHUSETTS: Forest Hills, Blue Hills; CONNECTICUT: East Hartford; NEW YORK: Ithaca,

Van Cortlandt Park, Riverhead, L.I., Sea Cliff, L.I., PENNSYLVANIA: Rockville; VIRGINIA: Vienna, Black Pond; NORTH CAROLINA: Highlands, Nantahala Gorge; SOUTH CAROLINA: Brunson, Charleston; GEORGIA: Atlanta, Ft. Gordon, Lawrenceville; ALABAMA: Coleta, Chambers Co., Tuscaloosa; MISSISSIPPI: Jackson; LOUISIANA: Minden, INDIANA: Lafayette; ILLINOIS: Beach, Muncie, Dixon Springs, Herod, Havana; WISCONSIN: Baraboo; IOWA: County 88; KANSAS: Riley Co., Onaga; TEXAS: Willis, Wallisville, Sharpsburg. Most dates of capture are for midsummer months; specimens taken in February, March, October, and November are marked as being taken under bark or in soil, where the females may possibly overwinter.

Variation in females. — There is considerable variation in the series available, but good reason to believe that all belong with this species. Two of the females (Sea Cliff, N.Y., and Atlanta, Ga.) are pinned with males, and a good many of the females are from areas where no other *Pristocera* occurs; from these specimens it is possible to obtain a good impression of the variation to be expected before specimens from within the range of other species need to be considered. The smallest specimen (Sea Cliff, N.Y.) is only 4.5 mm. long, LH 1.0 mm., LT 1.8 mm. The largest (Lawrenceville, Ga.) is 8.5 mm. long, LH 1.8 mm., LT 2.8 mm. While most specimens approximate the specimen described above in coloration, there are some striking variants. A specimen from Blue Hills, Mass., and another from Minden, La., have the head and thorax piceous, the abdomen dark reddish-brown; several others approach this condition but have the head and thorax somewhat paler. A striking specimen from Black Pond, Va., has the head piceous, the abdomen nearly as dark, and the thorax contrastingly rufo-castaneous except the middle and hind femora bright yellowish. Head shape varies slightly, LH/WH varying from 1.18 to 1.32; in some specimens the sides of the head bulge somewhat. Some variation can be noted in the size and spacing of the punctures of the head and thorax. While in all specimens the length of the propodeum approximates 2.1 X as long as its maximum width, as in the specimen described above, there is some variation in the degree to which the propodeum is constricted; the maximum condition is reached in the Lawrenceville, Ga., specimen, where the propodeum is 7.2 X as long as its minimum width, the maximum width 3.3 X the minimum width.

Remarks. — This is the most abundant and widely distributed member of the genus in North America. Ashmead (1893) stated

that he had examined the types of Westwood's *thoracica* and *contracta* in the Berlin Museum. Dr. G. Steinbach informs me that the types are not presently in that museum, and I have found that they are not in the Westwood Collection at Oxford nor at the British Museum. Ashmead placed *thoracica* in the synonymy of *atra*, stating that the type was from "Carolina" and that Westwood had suggested it represented the female of *atra*. Actually, Westwood had suggested in 1881 that *contracta*, not *thoracica*, was the female of *atra*. Since the type of *contracta* is in fact from "Carolina" and is a considerably larger insect than *thoracica*, it seems very probable that Ashmead was confusing the two names and intended to place *thoracica* in the synonymy of *armifera*. In any event, I am convinced that both of Westwood's names belong in the synonymy of *armifera*. The female here associated with *atra* is a striking insect which has not previously been described.

Through the courtesy of Mr. K. J. Heqvist of the Naturhistoriska Riksmuseet of Stockholm, I have recently had the opportunity to examine the type and paratypes of Kieffer's *reticulatus*. These specimens are perfectly typical males of *armifera* Say, which one assumes was otherwise unfamiliar to Kieffer. Kieffer based his genus *Acrepyris* on these specimens, placing the genus in the Epyrini and separating it from related genera by the fact that the scutellum lacked pits or a transverse furrow. Although the type and paratypes of *reticulatus* are pinned through the mesonotum, in all three specimens the transverse furrow at the base of the scutellum is evident.

2. Pristocera (Acrepyris) fraterna new species

Holotype. — ♂, NORTH CAROLINA: Kill Devil Hills, Dare Co., 29 July 1952 (K. V. Krombein) [USNM, no. 65675].

Description of type. — Length 7.5 mm. LFW 4.8 mm. Color black; tarsi dark brown; wings subhyaline, veins and stigma brown. Mandibles with five teeth, fourth tooth smaller than the others, basal tooth with a distinct cutting edge (Fig. 33). Clypeus slightly emarginate, its median carina weakly arched in profile. Antennae elongate, first four segments in a ratio of about 20:4:14:14, segment three 2.6 X as long as thick, segment eleven 4.5 X as long as thick; pubescence erect, pale, setulae of segment eleven two-thirds as long as thickness of segment. Eyes with only very weak, short hairs. Surface of head strongly polished, non-alutaceous; front, vertex, and temples with large punctures which for

the most part are separated by less than their own diameters, spaces between the punctures flat, not reduced to mere ridges as in *armifera;* front with a median impunctate strip which bears a linear impression. Head very slightly wider than high; WF .62 X WH, 1.33 X HE; WOT .9 X OOL. Pronotum somewhat larger than in *armifera,* its sides, as seen from above, weakly concave (Fig. 43); anterior face perpendicular to disc and to collar, both of which are irregularly transversely rugulose; setae pale, rather short; sides of pronotum striate. Mesonotum strongly polished, with small, well separated punctures. Propodeum as in *armifera* except sculpturing generally somewhat weaker; disc irregularly transversely striate. Characters of mesopleurum and fore wing as described for *armifera,* and claws as in that species. Subgenital plate as figured for *armifera.* Genitalia much as in *armifera* except as follows: parameres (Figs. 14, 15) more distinctly truncate apically and with a stronger lobe on inner ventral margin; aedoeagus (Fig. 40) with ventral valves prominently rounded apically, middle valves slightly exceeding ventral valves, dorsal valves forming thick apical lobes which are strongly reflexed ventrally.

Paratypes. — NORTH CAROLINA: 1 ♂, same data as type but dated 9 Aug. 1958 [KVK]; 1 ♂, Pisgah Forest, 12 Aug. 1957 (W. R. Richards) [CNC]; SOUTH CAROLINA: 1 ♂, Seneca, 9 Aug. 1957 (W. R. Richards) [CNC]; FLORIDA: 1 ♂, Fort George (Ashmead coll.) [USNM]; KANSAS: 1 ♂, Manhattan, 24 Sept. 1950 (H. E. Evans) [MCZ].

Variation in males. — Four of the five paratypes have the punctures on the sides of the lower front more crowded than in the type, such that in this area the space between them is reduced to a network of ridges, as it is over most of the head in *armifera.* LFW varies from 3.8 to 4.8 mm.; the type and the Kansas specimen are distinctly larger than any of the others.

Female (assigned here tentatively). — SOUTH CAROLINA: Isle of Palms, 3 June 1948 (O. L. Cartwright) [HKT].

Description of supposed female. — Length 5.8 mm., LH 1.12 mm., LT 1.85 mm. Body and appendages uniformly light castaneous. Mandibles and clypeus as in *armifera.* Head shining, barely alutaceous, punctures large, on middle of front separated by more than their own diameters (absent from median strip), on sides and under surface of head separated by mostly slightly less than their own diameters. LH 1.36 X WH, sides of head very weakly convergent to near posterior margin, where they are rounded off to the broad, straight vertex. Eye higher than

wide, with a large number of facets (more than 50); HE .18 X WH, very slightly greater than maximum width of flagellum. Antennae compact and slightly thickened apically, segment eleven about .8 as long as thick. Pronotal disc slightly longer than its maximum (posterior) width, its surface shining, weakly punctate. Mesonotum about as in *armifera* (pierced by pin). Propodeum 1.9 X as long as its maximum width, about 6 X as long as its minimum width, maximum width 3.4 X minimum width; surface strongly shining, with a few weak punctures confined to the extreme sides. Legs as in *armifera*.

Remarks. — Since the female *armifera* is quite variable, as noted under that species, it is difficult to be sure that the female described above is not simply an unusual *armifera*. However, I am inclined to think that it is not, and if I am correct then it must surely be the female of *fraterna*.

3. Pristocera (Acrepyris) californica new species

Holotype. — ♂, CALIFORNIA: Mill Creek Canyon, San Bernardino Co., 22 Sept. 1923 (E. P. VanDuzee) [CAS].

Description of type. — Length 7.5 mm., LFW 5.6 mm. Color black, basal three abdominal tergites suffused with dark reddish-brown apically and laterally, tarsi dark brown; wing veins brown, stigma nearly black. Mandibles with five teeth, fourth tooth very small, slightly smaller even than in Figure 33. Clypeus subtruncate apically, median carina arched in profile. Antennae very long, first four segments in a ratio of about 22:4:18:15, segment three 2.8 X as long as thick, segment eleven 3.9 X as long as thick; pubescence pale, erect, setulae of segment eleven about half as long as thickness of segment. Eyes with only weak, short hairs. Surface of head strongly polished, punctate except along a narrow, slightly depressed median strip; punctures of front large, separated by less than their own diameters though for the most part not actually contiguous, the spaces between them flat or round-topped; punctures of vertex, temples, and under surface of head smaller, separated for the most part by about their own diameters. Head slightly higher than wide, WH .95 X LH; WF .63 X WH, 1.37 X HE; WOT .76 X OOL. Pronotum with anterior face steep though not actually vertical, collar and sides polished, without rugae; disc polished, punctate, with a weak transverse elevation followed by a weak depression, much less evidently rugose than in *armifera*. Mesonotum polished, punctures small and well separated. Propodeum with median

carina strong but not quite reaching the transverse carina margining the declivity, the latter barely distinguishable from the adjacent rugae; disc with a pair of converging carinae which form a large basal triangle, with large foveae basally but otherwise transversely striate both inside and outside the triangle. Mesopleurum polished, punctures small and well separated, on the ventral surface almost impunctate. Claws dentate, as in *armifera*. Fore wing with discoidal cell well outlined, in fact the first recurrent vein weakly pigmented and the subdiscoidal vein nearly reaching the wing margin. Subgenital plate broadly rounded apically (Fig. 6). Genitalia not unlike those of *armifera*, but the parameres more elongate (Fig. 16); aedoeagus with middle valves sharply pointed and extending well beyond apices of ventral valves, apical lobes of dorsal valves slightly reflexed laterally (Fig. 41).

Paratypes. — CALIFORNIA: 1 ♂, Riverside, Oct. 1917 [CIS]; 2 ♂♂, Davis, Sept. (Bechtel, Schlinger) [UCD, MCZ]; 1 ♂, Yorba Linda, Orange Co., 31 Apr. 1934 [Los Angeles Co. Mus.]; 1 ♂, Winters, Yolo Co., 31 July 1933 [UCD]; UTAH: 1 ♂, Logan, Sept. 1943 (P. E. Telford) [USNM]; 1 ♂, White Valley, Sept. 1947 (R. A. Haws) [USNM]; WYOMING: 1 ♂, South Pass, 27 Aug. 1954, on *Achillea millefolium* (G. E. Bohart) [UCD].

Variation in males. — The paratypes vary in length from 6 to 8.2 mm., LFW 4.6 to 6.4 mm. In the specimens from White Valley, Utah, and South Pass, Wyo., the mandibles are 4-toothed, the small fourth tooth being entirely absent (Fig. 34). In several specimens there are weak rugae on the collar and sides of the pronotum. In some specimens the head is as wide or even slightly wider than high, but there is little variation in the other head measurements. In the three specimens from Yolo Co., Calif., the subgenital plate is more truncate apically than in the type.

Female. — Unknown.

4. Pristocera (Acrepyris) cockerelli new species

Holotype. — ♂, NEW MEXICO: Mesilla Park, 21 June 1898 (T. D. A. Cockerell) [USNM, no. 65676].

Description of type. — Length 6.8 mm., LFW 4.3 mm. Color black, abdomen dark reddish-brown; apical half of mandibles ferruginous; antennae dark castaneous; legs bright castaneous, coxae somewhat infuscated, tarsi light brown; wings hyaline, stigma brown, veins light brown. Mandibles with five strong

teeth (Fig. 32). Clypeus weakly emarginate, its median carina arched in profile. Antennae of moderate length, first four segments in a ratio of about 18:4:10:9, segment three 2.2 X as long as thick, segment eleven 2.6 X as long as thick; flagellar segments, especially middle ones, very slightly thickened in the middle, so that the antennae are submoniliform (Fig. 51); pubescence erect, pale, setulae of segment eleven one-third as long as thickness of segment. Eyes with scattered weak, short hairs. Head shining but covered with large punctures which are separated by much less than their own diameters, spaces between punctures round-topped or narrowly flat-topped, not actually forming a reticulum of ridges as in *armifera;* middle of front narrowly impressed. Head about as wide as high; WF .63 X WH, 1.40 X HE; WOT .8 X OOL. Pronotum shaped much as in *armifera;* collar and sides obscurely rugulose; disc subcarinate along edge of anterior declivity and also with a large transverse elevation parallel to and a short distance before the posterior margin. Mesonotum strongly shining, punctures small and well separated. Propodeum with a strong median carina which attains the transverse carina bordering the declivity, the latter also rather strong; disc with a large basal triangle bordered by carinae, with transverse ridges both inside and outside the triangle. Mesopleurum with large punctures much like the head, callus barely differentiated. Claws dentate. Fore wing with radial vein reaching slightly more than half-way from its base to the wing-tip and continued as a faint pigmented streak to wing margin; discoidal cell very faintly outlined. Subgenital plate emarginate, about as in *armifera.* Genitalia (Fig. 10) with the parameres rounded apically, grooved on the inner margin for reception of the elongate, curved digiti; aedoeagus unusual in that the dorsal valves terminate in four lobes, the lateral ones slender, the mesal ones shorter and more rounded, exceeded slightly by the acute middle valves.

Paratypes. — NEW MEXICO: 1 ♂, Mesilla, 13 Aug. (Cockerell) [MCZ]; 1 ♂, Dona Ana Co., 27 July 1954, swept from cotton (R. E. Fye) [USNM]; 1 ♂, Jemez Springs, 18 June 1916 (John Woodgate) [CU]; 1 ♂, Las Vegas, 6 August (Barber & Schwarz) [USNM]; ARIZONA: 1 ♂, southern part [USNM]; 1 ♂, Sabino Canyon, Pima Co., 14 March 1937 (R. A. Flock) [UA]; 1 ♂, St. David, 5 Nov. 1955 (G. D. Butler) [UA]; 1 ♂, Willcox, Cochise Co., 18 Aug. 1958 (on *Asclepias*, P. D. Hurd) [CIS]; TEXAS: 1 ♂, San Antonio, 10 Sept. 1942 (on window, E. S. Ross) [CAS]; MEXICO: SONORA: 1 ♂, Nogales, 28 June 1940, on cut flowers [USNM]; OAXACA: 1 ♂, Huajapan de Leon, 30

Sept. 1961 (J. Avila R.) [Escuela Nac. Agri., Chapingo, Mex.].

Variation in males. — The smallest male (Dona Ana Co., N. Mex.) is 4.8 mm. long, LFW 3.4 mm.; the largest (Jemez Springs, N. Mex.) is 8.6 mm. long, LFW 5.8 mm. Several Arizona and New Mexico specimens are darker than the type, having the abdomen nearly as dark as the head and thorax, the antennae dark brown, and the legs medium brown except for the paler tarsi. The specimens from Texas and Oaxaca are brightly colored, having the mandibles wholly castaneous, the legs bright yellowish-brown or ferruginous. The antennae of the Texas specimen are wholly castaneous and are filiform rather than submoniliform; the genitalia of this specimen differ in having more slender parameres and certain differences in the aedoeagus (Fig. 39). However, the genitalia of the specimen from Jemez Springs, N. Mex., are intermediate in structure between this specimen and the one selected as type. The Texas specimen lacks the median impression present on the front of all the remaining specimens in the series, and also has the abdomen wholly light castaneous. The only known female is associated with this Texas specimen. The Oaxaca specimen has the first two antennal segments ferruginous, but the antennae are otherwise as described for the type; in this specimen the abdomen is blackish and the genitalia virtually identical to those of the type. In this specimen the front is rather broad, WF measuring .67 X WH, 1.60 X HE.

Allotype. — ♀, TEXAS: San Antonio, 10 Sept. 1942 (on window, E. S. Ross) (on card point on same pin as ♂ paratype listed above) [CAS]

Description of allotype. — Length 5.2 mm., LH 1.10 mm., LT 1.9 mm. Uniformly bright castaneous, legs and tips of antennae very slightly paler than body. Mandibles and clypeus as in *armifera*. Head strongly shining, very weakly alutaceous, punctate in much the same way as in *armifera*. LH 1.25 X WH, sides of head weakly convergent to near posterior margin, then more abruptly convergent to a weakly concave vertex. Eye small, only slightly higher than wide, with only about 15 facets; HE about .12 X WH, distinctly less than maximum width of flagellum. Flagellum moderately thickened, segment eleven about .8 as long as thick. Pronotal disc 1.2 X as long as wide, shining, with some fairly strong punctures except along median line. Mesonotum about .8 as long as wide, with a few punctures. Propodeum 2.2 X as long as its maximum width, 6 X as long as its minimum width, maximum width 2.7 X minimum width; surface strongly shining, non-alutaceous, weakly punctate on

extreme sides. Femora and tibiae moderately compressed, middle tibiae with about 20 strong spines, hind tibiae with short, weak hairs.

5. Pristocera (Acrepyris) bridwelli new species

Holotype. — ♂, ARKANSAS: Dodd City, Marion Co., July 1897 (J. C. Bridwell), on card point on same pin as a female, the two labeled "in coitu afternoon on wooden wall in old sawmill" [USNM, no. 65677].

Description of type. — Length 6 mm., LFW 4.7 mm. Color black, abdomen dark brown, somewhat paler basally; mandibles dark reddish-brown; scape brown, flagellum dull castaneous; tegulae light brown, translucent; legs brown, tarsi light brown; wings hyaline, veins and stigma brown. Mandibles with five strong teeth. Clypeus broadly truncate, very slightly emarginate; median carina arched in profile. Antennae relatively short, first four segments in a ratio of about 17:4:10:8, segment three 1.9 X as long as thick; pubescence pale, suberect, setulae about one-third as long as thickness of flagellum (the right antenna is missing beyond segment four, the left antenna entirely missing). Eyes with only very short setae. Punctures of front large, contiguous, the interspaces reduced to mere ridges; punctures of vertex and temples not quite as close, interspaces flat-topped; median line of front narrowly impressed. Head slightly wider than high; WF .62 X WH, 1.4 X HE; vertex very broadly rounded, not strongly produced above eye tops; WOT .9 X OOL, lateral ocelli about equidistant from eye tops and margin of vertex. Pronotum with anterior face strongly polished; collar and sides obscurely rugose; disc short, subcarinate along anterior margin and with a very strong transverse elevation about midway, behind which it is flat. Mesonotum shining, punctures small and well separated. Propodeal disc short, median carina indistinct, posterior transverse carina fairly well developed, disc otherwise with coarse reticulate sculpturing. Mesopleurum with large, subcontiguous punctures, callus small, smooth and polished. Fore wing as described for *cockerelli*. Subgenital plate broadly truncate apically. Genitalia (Fig. 11) with the parameres broadly rounded apically, provided with an accessory flap on the ventral surface; aedoeagus with the middle valves much exceeding the ventral valves, the dorsal valves much exceeding the middle valves, forming very slender apical processes.

Allotype. — ♀, ARKANSAS: same data as type and on minuten nadeln affixed to same pin [USNM].

Description of allotype. — Length 6.2 mm., LH 1.45 mm., LT 2.3 mm. Body dark castaneous, abdomen somewhat paler and more shining than head and thorax; legs and antennae bright castaneous. Mandibles and clypeus as in *armifera*. Head shining, weakly and uniformly alutaceous; punctures small, separated by approximately their own diameters, absent from median strip. LH 1.14 X WH, sides of head distinctly bulged toward the middle, convergent behind to a straight vertex. Eye of moderate size, higher than wide, with more than 50 facets; HE about .16 X WH, distinctly greater than maximum width of flagellum. Flagellum moderately thickened, segment eleven about .85 X as long as thick. Pronotal disc slightly longer than wide, weakly and uniformly alutaceous, with well-defined punctures except along median line. Propodeum 2.1 X as long as its maximum width, 5 X as long as its minimum width, maximum width 2.3 X minimum width; surface weakly alutaceous and with well defined punctures over most of surface except median strip. Characters of legs as described for *armifera*.

6. Pristocera (Acrepyris) otomi new species

Holotype. — ♂, MEXICO: MEXICO: Atlacomulco, 8500 feet, 18 Aug. 1954 (J. G. Chillcott) [CNC, no. 7552].

Description of type. — Length 7.5 mm., LFW 5.6 mm. Entirely black; wings subhyaline, veins dark brown, stigma nearly black. Mandibles with five teeth, the fourth tooth smaller than the others. Clypeus broadly truncate, actually very weakly concave apically. Antennae elongate, first four segments in a ratio of about 24:4:19:16, segment three 2.3 X as long as thick, segment eleven 3.5 X as long as thick; pubescence whitish, suberect, setulae on segment eleven .4 as long as width of segment. Eyes with only weak, very short setae. Punctures of front large, subcontiguous, interspaces narrow, round-topped; punctures of vertex and temples separated for the most part by about half their own diameters; front with a linear median impression. Head about as high as wide, vertex very broadly rounded off a distance above eye tops about equal to HE; WF .68 X WH, 1.7 X HE, front thus relatively very wide; ocelli in a close triangle, front angle less than a right angle, WOT .6 X OOL. Pronotum with collar transversely striate and strongly setose; sides polished, with weak striae; anterior face short, with some sculpturing; disc moderately long, with weak and irregular transverse striae, with the usual transverse subapical depression. Mesoscutum with rather strong punctures, scutellum with weak punctures.

Propodeal disc with median carina strong, not quite reaching the transverse carina margining the disc posteriorly, the latter weak and somewhat irregular; disc with strong reticulations medio-basally, behind weakly reticulo-striate, basal triangle not clearly differentiated. Mesopleurum with a large number of small punctures which are separated by mostly somewhat less than their own diameters; callus convex, impunctate. Claws dentate, as in *armifera*. Fore wing with discoidal cell weakly outlined, subdiscoidal vein continued on beyond discoidal cell but terminating well before wing margin. Subgenital plate emarginate apically (about as figured for *armifera*, Fig. 5). Genitalia (Fig. 29) with parameres rather broad, rounded apically, margins simple except ventral margin with a small lobe; aedoeagus with ventral valves rather broad and wing-like, middle valves blunt, complex medio-apically and apparently with some pores on the mesal surface, dorsal valves terminating in well separated, slender, reflexed lobes.

Remarks. — The genitalia of this species are most like those of *bridwelli*, though there are a number of differences. However, the antennae are more elongate than in that species and the configuration of the pronotum is more like that of *armifera* and *californica*.

Female. — Unknown.

7. Pristocera (Acrepyris) oriplana Kieffer

Pristocera oriplana Kieffer, 1911, Ann. Soc. Sci. Bruxelles, 35: 215. [Type: ♂, MEXICO: GUERRERO: Omilteme, 8000 feet, Aug. (H. H. Smith) (BMNH)].

Propristocera oriplana Kieffer, 1914, Das Tierreich, 41: 487. —Evans, 1958, Proc. Ent. Soc. Wash., 59: 296.

Description of type. — Length 5.7 mm.; LFW 5.0 mm. Entirely black, including legs and antennae; wings subhyaline, veins and stigma dark brown. Mandibles with five teeth, fourth tooth somewhat smaller than the others. Clypeus truncate apically, its median carina arched in profile. First four antennal segments in a ratio of about 17:5:16:14, segment three 2.7 X as long as thick, segment eleven 4 X as long as thick; pubescence pale, suberect, setulae of segment eleven .7 as long as width of segment. Eyes not hairy. Front with large, subcontiguous punctures, interspaces for the most part reduced to round-topped ridges; punctures of vertex and temples less closely spaced; front with a median impression. WH 1.02 X LH; inner orbits convergent below, WF .61 X WH, 1.4 X HE. Ocelli

in a compact triangle, WOT .7 X OOL. Vertex rather narrowly rounded off a distance above eye tops nearly equal to eye height. Pronotum rather irregularly transversely rugulose, with one of the rugae toward the middle standing out somewhat above the others; disc with strong, transverse setigerous punctures which are more sparse along the major ruga. Mesoscutum polished, with small punctures; scutellar disc weakly punctate. Propodeal disc relatively elongate, actually about as long as wide; median carina strong for most of its length, also with some shorter longitudinal carinae on the sides basally, disc otherwise with transverse striae, the stria margining the disc behind barely differentiated from the others except somewhat stronger on the sides; basal triangle poorly differentiated, weakly depressed. Mesopleurum polished, its punctures shallow, obsolescent; callus small, impunctate. Claws dentate, the tooth fairly long but well separated from outer ray. Fore wing with discoidal cell weakly outlined, discoidal vein arising well down on transverse median vein, subdiscoidal vein weakly continuous to outer wing margin. Subgenital plate truncate. Genitalia (Figs. 2, 24, 31) with the parameres elongate, rounded apically, inner side with two small lobes; aedoeagus of unusual structure, ventral valves very long and slender, middle valves strong, hooked dorsad apically, dorsal valves hooked ventrad apically and more or less embracing apices of middle valves.

Other males examined. — Two, from the following localities: MEXICO: GUERRERO: 1, Amula, 6000 feet, Sept. (H. H. Smith) [BMNH]; 1, Tepetlapa, 3000 feet, June (H. H. Smith) [BMNH].

Variation. — The two above specimens are both smaller than the type (LFW 3.7-4.0 mm.) and both have the front somewhat narrower (WF about 1.27 X HE). The Amula specimen resembles the type closely in most respects, but the front is somewhat less coarsely and closely punctate and the propodeal disc more distinctly margined behind. The Tepetlapa specimen has the front strongly polished and the punctures still further reduced, rather irregularly spaced but with many of the interspaces fairly broad; this specimen also has the pronotum unusually smooth, with virtually no rugae or irregularities except for a transverse preapical impression. In spite of these differences, the genitalia are strikingly similar, so there seems little question that the three specimens are conspecific.

8. Pristocera (Acrepyris) erythropoda (Cameron)

Epyris erythropoda Cameron, 1888, Biol. Centr.-Amer., Hymen. I, p. 450, pl. 19, fig. 14. [Type: ♂, PANAMA: Volcan de Chiriqui, 3-4000 feet (G. C. Champion) (BMNH)].

Pristocera erythropoda Kieffer, 1908, Genera Insect., 76: 22. —Kieffer, 1914, Das Tierreich, 41: 467.

Description of type. — Length 8 mm., LFW 5.5 mm. Head and thorax black, basal three segments of abdomen dark brown except basal segment suffused with light brown on sides, remainder of abdomen light rufo-castaneous; mandibles and clypeus rufo-castaneous; antennae light yellowish-brown, apical segment somewhat infuscated; tegulae testaceous; legs pale castaneous except hind femora and all the coxae brown; wings subhyaline, lightly tinged with yellowish-brown, fore wing vaguely infuscated about basal vein and with a preapical brownish band which starts at the stigma and radial vein, where it is strong, and extends to the posterior margin of the wing. Body hairs golden, rather short and not especially dense. Mandibles with five teeth, fourth tooth somewhat weaker than the others (about as in Fig. 32). Clypeus truncate apically, its median carina weakly arched in profile. Antennae with first four segments in a ratio of about 23:5:15:14, segment three 3 X as long as thick, segment eleven 4 X as long as thick; pubescence whitish, erect, setulae of segment eleven about half as long as width of segment. Head shining, with strong punctures which, on the sides of the front, tend to be subcontiguous in longitudinal rows; center of front, vertex, and temples with punctures well separated. Eyes not hairy. Front rather narrow, WF .60 X WH, 1.3 X HE; ocelli in a small triangle, front angle less than a right angle, WOT .8 X OOL. Pronotum with anterior face strongly polished, nearly perpendicular to collar and to disc; sides polished, with some very weak rugae; disc transversely rugose anteriorly, then with a strong transverse ridge behind which it is depressed and nearly smooth. Mesonotum shining, with strong punctures on the sides, weaker punctures medially. Propodeum with basal triangle small, margined by a strong carina; median carina absent in front, weak behind; posterior transverse carina well defined; most of disc covered with strong, well spaced transverse ridges. Mesopleurum with large, well-separated punctures, callus smooth and polished. Claws with middle tooth erect, nearly as long as outer tooth, making the claws appear somewhat bifid (Fig. 57). Fore wing with the discoidal and subdiscoidal veins indicated by pigmented streaks, the latter nearly

reaching the wing margin, but the vein closing off the outer side of the discoidal cell barely pigmented. Abdomen slender, polished, apically with golden setae. Subgenital plate emarginate. Genitalia (Fig. 4) with parameres unusually short, broadly truncate; aedoeagus with middle valves prominent, much exceeding ventral valves, dorsal valves terminating in a pair of slender lobes connected by membrane.

Other males examined. — Two, from the following localities: PANAMA: 1, Bugaba (G. C. Champion) (BMNH); COSTA RICA: 1, Turrialba, 25 June 1949 (K. W. Cooper) [USNM].

Variation. — The two above specimens are slightly larger than the type (LFW 5.8 in both), but there are no important differences in sculpturing or in standard measurements. In the Costa Rica specimen the legs are somewhat darker, the middle and hind legs being brown except for the tarsi.

Remarks. — This striking species has no close relatives, although the pronotum and the genitalia suggest *cockerelli* and *bridwelli* more than any other species. The color pattern is strikingly like that of the Brazilian *Pseudisobrachium haemorrhoidalis* (Westwood).

Female. — Unknown.

9. Pristocera (Acrepyris) orizabae (Cameron) new combination

Epyris orizabae Cameron, 1897, Ann. Mag. Nat. Hist., (6)19:273. [Type: ♂, MEXICO: VERACRUZ: Orizaba, Dec. 1887 (H. H. Smith) (BMNH)]. —Cameron, 1899, Biol. Centr.-Amer., Hymen. I, Suppl., p. 473.

Description of type. — Length 7 mm.; LFW 5.4 mm. Head and thorax black, abdomen dark brown; palpi brown; mandibles black except somewhat rufous apically; antennae very dark brown; legs very dark brown except tips of tarsi light brown; wings subhyaline, veins and stigma dark brown. Mandibles with five strong teeth. Clypens truncate except very weakly produced medially. First four antennal segments in a ratio of about 20:4:15:13, segment three twice as long as thick, segment eleven three times as long as thick; pubescence pale, suberect, setulae of segment eleven .5 as long as width of segment; basal segments of flagellum distinctly flattened, in profile very weakly serrate. Eyes with some short hairs above. Front very coarsely punctate, interspaces reduced to round-topped ridges; punctures of vertex and temples somewhat smaller and more widely separated; front weakly impressed medially. WH 1.03 X LH; inner

orbits convergent below, WF .54 X WH, 1.22 X HE. Ocelli in a right triangle, WOT .88 X OOL. Vertex broadly rounded off a distance above eye tops equal to not much over half HE. Pronotum rather short (Fig. 46), coarsely punctate, with smooth contours except depressed subapically. Mesoscutum polished, with small, rather evenly spaced punctures. Propodeal disc with basal triangle not clearly marked off, filled with longitudinal carinae; median carina strong, flanked by a series of reticulations, reaching the transverse carina, which is unusually well formed for the genus; latero-posterior parts of disc with weak, irregular sculpturing; extreme posterior part of disc, and posterior slope, strongly reticulate. Mesopleurum polished, strongly punctate. Claws dentate, the tooth strong and sloping outward somewhat. Fore wing with discoidal cell outlined by pigmented lines; first recurrent vein distinct; subdiscoidal vein continuing to outer wing margin as a pigmented streak. Subgenital plate truncate. Genitalia with the parameres simple, tapering to a narrowly rounded apex (Fig. 22); aedoeagus with the dorsal valves slightly exceeding the strong middle valves, their apices reflexed strongly ventrad (Fig. 30).

Remarks. — This species is known only from the type. It was apparently overlooked by Kieffer in his review of the Bethylidae in Das Tierreich, 1914. The species is an interesting one, since it resembles *hyalina* and related species in most respects, yet has the eyes weakly hairy, an aedoeagus somewhat resembling that of *fraterna*, and parameres not unlike those of *atra*.

Female. — Unknown.

10. Pristocera (Acrepyris) atra Klug

Pristocera atra Klug, 1810, Beitr. Naturk., 2: 206. [Type: ♂, GEORGIA (said by Ashmead, 1893, to be in Berlin Mus.; I have not seen it)]. —Westwood, 1874, Thes. Ent. Oxoniensis, p. 163, pl. XXXI, fig. 5. —Ashmead, 1893, Bull. U. S. Nat. Mus., 45: 33-34. —Kieffer, 1914, Das Tierreich, 41: 465.

Plesiotype. — ♂, GEORGIA: Milledgeville, 25 April 1940 (P. W. Fattig) [USNM].

Description of plesiotype. — Length 13.5 mm.; LFW 8.5 mm. Entirely black, apices of tibiae weakly tinged with rufous; fore wing wholly weakly infuscated, hind wing subhyaline. Mandibles 5-toothed, prominent, lower margin but weakly curved, teeth in a strongly oblique series (Fig. 54). Clypeus truncate, median carina abruptly declivous near margin. Antennae elongate, first

four segments in a ratio of about 15:2:13:12, segment three 1.9 X as long as its maximum width, segment eleven 3.6 X as long as thick; middle segments of antennae, most particularly 4-9, slightly depressed and slightly thickened apically on the under side, so that in lateral view the antennae are subserrate (Fig. 48); pubescence erect, light brown, setulae on segment eleven about one-fourth as long as thickness of segment. Eyes with some weak, short hairs. Head shining, strongly punctate, punctures on front so close together that the interspaces form a network of round-topped ridges, punctures on vertex and temples slightly weaker and more widely separated. Head slightly wider than high; WF .64 X WH, 1.45 X HE; vertex very broad, in the center almost straight; ocelli in a broad, flat triangle, WOT and OOL subequal. Pronotum with anterior face perpendicular to disc and to collar; collar, anterior face, and sides all weakly rugose; disc short, transverse, without strong rugosities but transversely depressed just before posterior margin, region anterior to this depression transversely rugoso-punctate. Mesonotum shining, rather weakly punctate, especially medially. Propodeal disc with strong reticulate sculpturing, basally with short longitudinal carinae, median carina the longest but not reaching posterior margin of disc as a clearly defined carina; transverse carina margining the disc behind moderately well defined, weakly arching on each side. Mesopleurum with a great many small punctures which are separated by mostly less than their own diameters; callus small, with minute punctures. Claws dentate, tooth small, erect. Fore wing with radial vein extending half way from its base to wing tip, then continued nearly to tip as a pigmented streak; discoidal cell fully outlined by pigmented lines, subdiscoidal vein extending on nearly to wing margin; first recurrent vein well pigmented; cubital vein weakly pigmented and extending nearly to wing margin. Subgenital plate emarginate apically, much as figured for *armifera* (Fig. 5). Genitalia (Figs. 12, 17) with characteristically shaped parameres; aedoeagus with middle valves much exceeding ventral valves, acutely pointed; lobes of dorsal valves prominent, somewhat boot-shaped.

Males examined. — I have examined 37 males, from the following localities: NORTH CAROLINA: 2, Southern Pines, April (S. W. Foster) [MCZ]; 1, Columbus Co., April (H. K. Townes) [HKT]; 1, no further data (T. Pergande) [USNM]. SOUTH CAROLINA: 1, Salina, March (H. K. Townes) [HKT]. GEORGIA: 1, Milledgeville, April (P. W. Fattig) [USNM];

1, Fort Valley, June (O. I. Snapp) [USNM]; 1, Thomasville, June (W. D. Pierce) [USNM]. FLORIDA: 1, Titusville, 1919 (Griffin) [CM]; 1, 4 mi. W. Titusville, March (Howden & Howell) [CNC]; 2, Lake Placid, Feb., July (Crowder; Cazier) [KU, AMNH]; 3, Alachua Co., March, June [FSPB]; 2, no further data [USNM]; 1, Crescent City, June (C. T. Brues) [MCZ]; 1, 3 mi. SW Micanopy, Marion Co., April (T. H. Hubbell) [FSPB]; 1, Georgetown, Nov. 1948 (C. T. Brues) [MCZ]. MISSISSIPPI: 1, Natchez, May (E. S. Tucker) [USNM]. LOUISIANA: 7, Opelousas (G. R. Pilate) [USNM]; 1, Natchitoches, May [USNM]. TEXAS: 1, Willis, May (J. C. Bridwell) [USNM]; 1, Gilmer, Upshur Co., April (J. G. Hall) [UCD]; 1, Lexington, April (L.D. Beamer) [KU]; 1, nr. Lufkin, Angelina Co., May (W. Gertsch) [AMNH]; 1, Mineola, July (F. C. Bishopp) [USNM]; 1, Calvert (C. R. Jones) [USNM]; 1, Hearne, April (W. W. Yothers) [USNM]. NEW MEXICO: 1, Aden, July [MCZ].

Variation in males. — This species shows great variation in size. Several specimens from the Carolinas, Georgia, and Florida approximate in size the plesiotype described above, but most specimens are smaller. The smallest specimen (Opelousas, La.) measures only 6 mm. long, LFW 5 mm. The mean LFW of specimens from various states is as follows: N.C. 7.5, S.C. 6.5, Ga. 7.1, Fla. 6.8, Miss. 5.1, La. 6.4, Tex. 6.3, N. Mex. 6.4. The wings vary from moderately infuscated (sometimes more distinctly so on the apical third) to clear hyaline, the wings of some Texas and the New Mexico specimen being especially pale, the veins light brown; in these latter specimens most of the veins and pigmented lines beyond the basal and radial veins are absent. The New Mexico specimen further differs in having the vertex rounded off only a short distance above the eye tops. The specimen from Crescent City, Florida, has the antennae, legs, and abdomen dark castaneous, contrasting to the black head and thorax. I had originally segregated this specimen and that from Aden, N. Mex., as distinct species, but the genitalia appear identical to those of *atra* as do most other structural features.

Plesiallotype. — ♀, TEXAS: Cleveland, 6 June 1934, *ex* armadillo [USNM].

Description of plesiallotype. — Length 6.6 mm., LH 1.23 mm., LT 2.2 mm.; abdomen unusually elongate, nearly 4 X as long as maximum width. Uniformly castaneous, tips of antennae slightly paler. Mandibles slender and of unusual form, lower margin bent downward and bearing some long setae; apical tooth

large, second and third teeth small, rounded, basal tooth prominent and angular; basal three teeth drawn well back along inner mandibular margin (Fig. 53). Clypeus truncate, with a high median ridge. Head shining, non-alutaceous; punctures strong but very sparse on vertex and median third of front, on sides and under side of head separated by roughly their own diameters. Head rather convex in cross-section, slender, LH 1.3 X WH, sides of head weakly convergent to near posterior margin, then abruptly convergent to a rather narrow, straight vertex. Eye small, with 16-20 ill-defined facets; HE about .13 X WH, distinctly less than maximum width of flagellum. Flagellum strongly thickened apically, segment eleven about .7 as long as thick. Pronotal disc rather flat, gradually broadened posteriorly, length .3 X maximum width; disc shining and with five asymmetrically placed punctures. Disc of mesonotum slightly wider than long, shining and impunctate. Propodeum unusually elongate, length 2.35 X as long as maximum width, 4.6 X as long as minimum width, maximum width only about twice minimum width; disc shining, non-alutaceous, impunctate. Mesopleurum unusually flat, shining, with only a few punctures. Femora strongly expanded and flattened, tibiae also somewhat flattened; middle tibiae with thick, spinelike setae mixed in with the spines, hind tibiae also with dense, thick, almost spinelike setae.

Remarks. — Various females have from time to time been associated with *atra*, but all of these are, in my opinion, simply large or unusually colored females of *armifera*. The female described above is sufficiently unusual to belong to a different species complex from *armifera*, and the structure of the mandibles suggests *atra* as the probable male. The significance of the ecological data on the specimen (*ex* armadillo) I do not know; presumably its occurrence on that host was accidental.

11. Pristocera (Acrepyris) hyalina Brues

Pristocera hyalina Brues, 1906, Bull. Wisc. Nat. Hist. Soc., 4: 143. [Type: ♂, TEXAS: Austin (C. T. Brues) (Milwaukee Public Museum)]. —Kieffer, 1914, Das Tierreich, 41: 465.

Plesiotype. — ♂, TEXAS: Houston, 6 July 1939 (J. Vick) [MCZ].

Description of plesiotype. —Length 7.5 mm., LFW 5.5 mm. Entirely black except flagellum, palpi, and apices of legs dark brown; body densely clothed with whitish pile; wings subhyaline, veins brown, stigma almost black. Mandibles five-toothed

and with the lower margin strongly arched, about as in Figure 32. Clypeus truncate and with a high, arched median carina. Antennae elongate, first four segments in a ratio of about 20:4 15:14, segment three 1.6 X as long as thick, segment eleven 3.5 X as long as thick; middle antennal segments very weakly thickened apically beneath, so that the antennae are very indistinctly serrate in profile (Fig. 50); pubescence pale, bristling, setulae on segment eleven about one-fourth as long as width of segment. Eyes with a band of rather long hairs just above the middle. Head shining, non-alutaceous, with many strong though small punctures which for the most part are separated by less than their own diameters; on the sides of the front the punctures are very close and tend to form longitudinal series. Head about as wide as high; front broad; vertex broadly rounded off well above eye tops; WF .63 X WH, 1.4 X HE; ocelli in a broad, rather flat triangle, WOT 1.2 X OOL. Pronotum with the disc short, transversely depressed posteriorly, anteriorly rounded into the vertical anterior face (Fig. 45). Mesonotum strongly shining, both scutum and scutellum wholly covered with strong, well-separated punctures. Propodeum with basal triangle set off by a shallow depression bordered by an irregular carina; median carina strong, reaching the transverse posterior carina, the latter barely discernible amid the reticulate sculpturing. Mesopleurum with a large number of rather small punctures; callus small, weakly punctate. Claws dentate, the tooth short, erect. Fore wing with radial vein rather long and continued nearly to wing tip as a pigmented streak; discoidal cell fully outlined by pigmented lines; cubitus and first recurrent vein represented by weakly pigmented lines; subdiscoidal vein continuing nearly to wing margin as a weakly pigmented streak. Abdomen stout, shining, with abundant setae on the apical segments. Subgenital plate emarginate, about as figured for *armifera* (Fig. 5). Genitalia (Figs. 18, 25) with the parameres strongly excavated on the inner margin such that they present a characteristic profile in both ventral and lateral views; aedoeagus with middle valves terminating in a pair of slender processes which are nearly as long as the lobes of the dorsal valves, the latter thin and somewhat twisted.

Males examined. — Nine, from the following localities: LOUISIANA: 1, Opelousas, March 1897 (G. R. Pilate) [USNM]. TEXAS: 2, Iron Bayou, between Henderson and Carthage, 17 April (A. Stone) [USNM]; 1, Houston, July (J. Vick) [MCZ]; 1, Austin (C. T. Brues) [type, Milwaukee Museum]; 1, San

Antonio, 24 May 1941 [CAS]; 1, 1 mi. S. Marathon, Brewster Co., 17 July 1950 (R. F. Smith) [AMNH]; 1, 7 mi. NE Dell City, Hudspeth Co., 31 July 1950 (R. F. Smith) [AMNH]. NEW MEXICO: 1, Roswell, 12 Sept. 1937 (R. H. Crandall) [UA].

Variation. — The males vary in size from 6 to 9.5 mm., LFW from 4.5 to 7 mm. The specimens from Austin and from western Texas and New Mexico have the wings clear hyaline, the discoidal, subdiscoidal, and recurrent veins barely if at all evident. On the other hand, the Louisiana specimen has the wings lightly clouded on the apical half. This specimen also has the flagellar pubescence very short (setulae of segment eleven only about .2 as long as width of segment) and the ventral valves of the aedoeagus broader and more acute apically than in the other specimens. In several specimens the antennae are shorter than described above (segment eleven about 2.5 X as long as thick) and not at all serrate; in three of the East Texas specimens, most particularly in the type, the ocellar triangle is rather compact, the front angle less than a right angle, the ocello-ocular line exceeding the width of the ocellar triangle.

Remarks. — Unfortunately, the type of this species is a "humbug": the abdomen is missing, and the abdomen of a *Sicrolomorpha* (minus the first segment) is glued to the side of the mount. This specimen (that is, the head and thorax) is also unusually small (LFW 4.5 mm.) and has shorter antennae and a more compact ocellar triangle than is typical of most members of the series before me. For these reasons I have preferred to base my description on a different specimen. I have little doubt that the type is conspecific with the other specimens considered here, but since the genitalia are missing it may never be possible to be certain of this. I am indebted to Dr. Kenneth MacArthur of the Milwaukee Public Museum for letting me borrow the type of this species.

Female. — Unknown.

12. Pristocera (Acrepyris) intermedia new species

Holotype. — ♂, MEXICO: SAN LUIS POTOSI: 18 mi. S. of San Luis Potosi, 1 Sept. 1958 (H. F. Howden) [CNC, no. 7551].

Description of type. — Length 7.5 mm., LFW 5.2 mm. Entirely black; body densely clothed with long, whitish pile; wings moderately heavily infuscated except apical fourth of fore wing paler, veins dark brown, stigma black. Mandibles with five well-developed teeth, about as in Figure 32. Clypeus truncate, its

median carina relatively low. Antennae elongate, first four segments in a ratio of about 20:4:16:15, segment three gradually expanded apically, about twice as long as its maximum width, segment eleven nearly 5 X as long as wide; flagellar segments, except apical four, slightly thickened apically so that the antennae are indistinctly subserrate; pubescence whitish, bristling, setulae of segment eleven .3 as long as width of segment. Head strongly shining, non-alutaceous, punctures relatively weak: punctures on sides of lower front shallow, separated by mostly somewhat less than their own diameters; punctures of upper front and temples very shallow, well separated. Eyes with a few long hairs on upper part. Head slightly wider than high, vertex broadly rounded off a distance above eye tops about equal to eye height; front broad, eyes slightly convergent below; WF .62 X WH, 1.45 X HE; front angle of ocellar triangle about a right angle, WOT .85 X OOL. Pronotal disc somewhat longer than in *hyalina,* about as in *tenochca* (Fig. 44); pronotum with even contours, densely punctate and setose. Mesonotum strongly shining, punctures small, rather sparse medially. Propodeum with basal triangle set off by a shallow depression, longitudinally ridged, remainder of disc with rather strong and regular transverse striae. Mesopleurum strongly shining, with many small punctures which are separated by somewhat more than their own diameters. Claws dentate. Fore wing with discoidal cell weakly outlined, subdiscoidal vein continued beyond it nearly to wing margin, first recurrent vein weakly indicated. Subgenital plate truncate apically. Genitalia with the lateral elements about as in *hyalina;* aedoeagus (Fig. 38) with the ventral valves slender, the middle valves acute and extending about .6 the distance from the apices of the ventral valves to the apices of the dorsal valves, the latter structures somewhat thicker than in *hyalina* and less distinctly twisted than in that species.

Female. — Unknown.

13. Pristocera (Acrepyris) tenochca new species

Holotype. — ♂, MEXICO: MORELOS: 9 mi. N. of Cuernavaca, 8500 feet, 27 June 1959 (H. E. and M. A. Evans) [MCZ, no. 30285].

Description of type. — Length 7.5 mm., LFW 5.8 mm. Entirely black; wings subhyaline, with dark setulae, veins dark brown, stigma nearly black; body clothed with whitish pile of moderate length but slightly less dense than in *hyalina* and in

the three species which follow. Mandibles with five teeth, about as in Figure 32. Clypeus rather narrowly subtruncate, weakly notched medially, median carina high and arched. Antennae elongate, first four segments in a ratio of about 22:5:17:15, segment three 2.2 X as long as thick, segment eleven 3.7 X as long as thick; basal flagellar segments weakly depressed, but with no suggestion of serrations; pubescence erect, pale golden, setulae of segment eleven about .4 as long as thickness of segment. Eyes with a band of long hairs just above the middle. Head shining, non-alutaceous; punctures of front strong, separated by generally less than half their own diameters, punctures of vertex and temples very slightly more widely spaced; front with a strong median groove in front of the anterior ocellus. Head about as wide as high; front broad, WF .63 X WH, 1.45 X HE; ocelli in a right triangle, WOT .8 X OOL. Pronotum with disc of moderate length (Fig. 44) closely punctate, transversely depressed before posterior margin; sides and collar striate. Mesonotum shining and almost impunctate medially, sides closely punctate. Propodeum with basal triangle set off by a shallow depression, sculpturing rather irregular, somewhat transverse behind; median carina strong, but no transverse carina behind which is clearly set off from the general sculpturing. Mesopleurum with punctures rather small, separated for the most part by slightly more than their own diameters; callus elongate, weakly punctate, continuous with a longitudinal ridge passing anteriorly and giving rise to some vertical striations. Claws not strongly bent, tooth small, erect. Fore wing with discoidal cell outlined by pigmented lines and subdiscoidal vein continuing nearly to wing margin. Abdomen stout, shining, strongly setose apically. Subgenital plate shallowly emarginate apically. Genitalia with the lateral elements not differing noticeably from those of *hyalina*, shown in Figure 18; aedoeagus (Fig. 37) with the middle valves very prominent and acute, extending about .7 the distance from the apex of the ventral valves to the tip of the aedoeagus; apical lobes moderately thick, hollowed out on the inner margin.

Paratype. — ♂, MEXICO: MEXICO: Agua Bendita, 9700 feet, 2 Aug. 1962 (H. E. Evans) [MCZ].

Variation. — The paratype is slightly smaller than the type (LFW 5.0 mm.) but is closely similar to it in all respects, including the distinctive antennae and aedoeagus. In this specimen antennal segment eleven measures 3.2 X as long as thick; WF is 1.40 X HE, WOT .83 X OOL.

Remarks. — Both type and paratype were collected near the ground in open fields in forested areas at high elevations. This species bears much resemblance to *hyalina*, but the pronotum is slightly longer and less densely hairy, the antennae are slightly longer and more strongly pubescent, and the sculpturing of the propodeum is slightly different.

Female. — Unknown.

14. Pristocera (Acrepyris) nebulosa new species

Holotype. — ♂, GUATEMALA: Cerro Zunil, 4-5000 feet (G. C. Champion) [BMNH].

Description of type. — Length about 10 mm.; LFW 7.8 mm. Head and thorax black, abdomen piceous; scape black, flagellum very dark brown; legs nearly black except tips of tarsi fading to medium brown; fore wing subhyaline basally, apical half (starting below stigma) distinctly infuscated; hind wing lightly infuscated on apical half. Body clothed rather densely with whitish erect setae. Mandibles with five teeth, the fourth tooth somewhat smaller than the others (about as in Fig. 32). Clypeus broadly emarginate apically, its median carina arched in profile. Antennae elongate, first four segments in a ratio of about 32:6:27:23, segment three 3 X as long as thick, segment eleven 5 X as long as thick; basal flagellar segments rather strongly flattened, as seen in profile only very slightly thickened apically; pubescence erect and bristling, setulae of segment eleven .8 as long as width of segment. Eyes with some short hairs on upper part. Front entirely covered with coarse punctures, the interspaces reduced to a reticulum of round-topped ridges; front weakly impressed along the midline. WH 1.05 X LH; WF .60 X WH, 1.36 X HE; ocelli in a compact triangle, front angle very slightly less than a right angle; WOT .7 X OOL. Vertex broadly rounded off a distance above eye tops equal to about two-thirds HE. Pronotal disc moderately long, about as in *tenochca* (Fig. 44), along the midline measuring about three-fourths as long as mesoscutum; surface densely covered with transverse setigerous punctures; sides and collar weakly striate. Propodeal disc about 1.2 X as wide as long; median carina complete; basal triangle weakly depressed but not bordered by carinae, basally with some short longitudinal carinae, apically with transverse carinae; disc rather weakly sculptured and shining postero-laterally, but the declivity coarsely reticulate, the declivity not otherwise separated from the disc. Mesopleurum

covered with strong punctures. Claws strongly bent, tooth small but subparallel to outer ray, subtruncate apically (Fig. 59). Fore wing with discoidal cell strongly outlined, subdiscoidal vein strong nearly to wing margin, first recurrent vein also strongly pigmented. Subgenital plate emarginate apically (Fig. 8). Genitalia (Figs. 21, 23) having the general form of those of *hyalina*, the parameres bent slightly laterad at their tips; aedoeagus with the middle valves very strong, as in *hyalina* and *tenochca*, the dorsal valves somewhat thicker than in those species.

Remarks. — There can be no doubt of the close relationship of this species to *hyalina* and *tenochca*, but the eyes are less prominently hairy and the genitalia slightly different. The unusual claws and the weakly hairy eyes suggest *rugifrons*, and in fact the type is a paratype of Cameron's *rugifrons*. However, the longer pronotum and longer middle valves of the aedoeagus readily distinguish it from that species; also, the tooth of the claws is more slender and less conspicuously truncate.

Female. — Unknown.

15. Pristocera (Acrepyris) varidens (Cameron) new combination

Epyris varidens Cameron, 1904, Trans. Amer. Ent. Soc., 30: 262. [Type: ♂, MEXICO (no further data) (BMNH)]. —Kieffer, 1914, Das Tierreich, 41: 344.

Pristocera alticola Kieffer, 1911, Ann. Soc. Sci. Bruxelles, 35: 213. [Type: ♂, MEXICO: GUERRERO: Xucumanatlan, 7000 feet, July (H. H. Smith) (BMNH)]. New synonymy. —Kieffer, 1914, Das Tierreich, 41: 466.

Description of type. — Length 8.2 mm., LFW 6.0 mm. Entirely black, including legs and antennae, latter with a bluish cast; wings lightly tinged with brownish, setulae dark, veins brown, costa, subcosta, and stigma nearly black; head and thorax clothed rather densely with long, whitish hairs. Mandibles with four teeth, a considerable gap separating the basal two teeth (as in Fig. 35). Clypeus with a broadly V-shaped emargination, median carina low, not arched. Antennae elongate, first four segments in a ratio of about 24:5:22:20, segment three 2.3 X as long as thick, segment eleven about four times as long as thick; basal segments of flagellum slightly depressed, very weakly serrate in profile; pubescence suberect, light brown, rather dense and short as compared to preceding two species, setulae of segment eleven only .3 as long as thickness of flagellum. Eyes with long setae on upper half. Head shining, strongly

punctate, punctures of sides of front very crowded, those of vertex and temples weaker and well separated; front with a strong linear median impression. WH 1.05 X LH; front of moderate breadth, WF .58 X WH, 1.35 X HE; ocelli in a right triangle, WOT .9 X OOL. Vertex broadly rounded off a distance above eye tops about equal to HE. Pronotal disc moderately long, with the usual transverse subapical depression, contours otherwise rather even (shape about as in *tenochca,* Fig. 44); punctures close; sides and collar striate. Mesonotum shining, punctures sparse medially, crowded laterally. Basal triangle of propodeum small, margined by a carina, disc shallowly depressed bordering outside of carina; entire disc outside triangle with rather strong, regular transverse rugae. Mesopleurum polished, with small punctures even on callus. Claws dentate, the tooth acute, sloping outward somewhat, subparallel to outer ray. Fore wing with radial vein continued as a pigmented streak nearly to wing tip, discoidal cell fully outlined by pigmented streaks, subdiscoidal vein continued as a faint streak nearly to wing margin, first recurrent vein also weakly indicated. Subgenital plate shallowly emarginate. Genitalia with the lateral elements much as in related species (as in Figs. 18, 20); aedoeagus (Fig. 36) much as in *tenochca* but the middle valves shorter, extending only about half the distance from the apex of the ventral valves to the tip of the aedoeagus; apical lobes of dorsal valves slightly thicker and more bulbous than in *tenochca,* less so than in *chihuahua.*

Other males examined. — Eight, from the following Mexican localities: MORELOS: 1, 4 mi. NW Cuernavaca, 7500 feet, 28 June 1959 (H. E. Evans) [MCZ]; 1, YMCA Camp, Tepoztlan, 21 Aug. 1958 (H. F. Howden) [CNC]; MEXICO: 1, 10 miles E. of Toluca, 8900 feet, 31 July 1954 (J. G. Chillcott) [CNC]; 1, Real de Arriba, Temascaltepec, 10 July 1933 (H. E. Hinton & R. L. Usinger) [CAS]; PUEBLA: 1, Atlixco, 13 Aug. 1903 (W. L. Tower) [AMNH]; QUERETARO: 1, 10 mi. E. of San Juan del Rio, 30 July 1954 (J. G. Chillcott) [CNC]; MICHOACAN: 1, Tuxpan, 11 July 1951 (P. D. Hurd) [CIS]; GUERRERO: 1, Xucumanatlan, July (H. H. Smith) [type of *alticola,* BMNH].

Variation. — The specimens from Cuernavaca, Toluca, Tuxpan, and San Juan del Rio have the mandibles five-toothed, but in all the others they are four-toothed. The wings vary from nearly hyaline to somewhat clouded, and in the San Juan del Rio and Tuxpan specimens the wings are heavily infuscated except

apically. Variation in mandibular dentition is known in other species (*californica*, *chihuahua*) and considerable variation in wing color is also exhibited by other species (*atra*, *hyalina*, and especially *chihuahua*). Thus I believe all eight specimens to belong to one species, and the genitalia confirm this. The smallest specimen is that from Tepoztlan (LFW 5.4 mm.), the largest that from Atlixco (LFW 9 mm). The strength of the tooth of the tarsal claws shows an unusual amount of variation in this species; in the type of *alticola* it is unusually long, as illustrated by Kieffer. However, this specimen stands very close to the type of *varidens* in all other respects, including the genitalia, and I cannot believe that it is specifically distinct. In the Tuxpan specimen the claws are identical to those of the type of *alticola*.

Female. — Unknown.

16. Pristocera (Acrepyris) chihuahua new species

Holotype. — ♂, MEXICO: CHIHUAHUA: Catarinas, 5800 feet, 26 July 1947 (D. Rockefeller Exp.; W. Gertseh) [AMNH].

Description of type. — Length 12 mm.; LFW 8.1 mm. Black, first abdominal segment suffused with light brown laterally and apically; flagellum dark brown; wings wholly fuliginous except apex of fore wing somewhat paler; head, thorax, legs, and apical parts of abdomen densely clothed with pale setae. Mandibles with four teeth (Fig. 35). Clypeus with a broadly V-shaped emargination, median carina arched in profile. Antennae very long, first four segments in a ratio of about 30:5:28:26, segment three 2.3 X as long as its greatest width, segment eleven 4 X as long as wide; flagellar segments (except apical two) slightly depressed, very slightly widened apically, such that the profile is very weakly serrate (Fig. 49); pubescence very short, setulae of segment eleven about .15 X as long as width of segment. Eyes with several long hairs in a band on the upper part. Head strongly shining, punctures relatively shallow and weak but quite numerous, subcontiguous except more widely spaced on vertex; front with a median impression in front of anterior ocellus. Head about as wide as high, vertex broadly rounded off far above eye tops; front broad, WF .60 X WH, 1.42 X HE; ocelli in a rather flat triangle, front angle greater than a right angle, WOT and OOL subequal. Pronotal disc short, with even contours except for posterior transverse depression, densely punctate. Mesoscutum and scutellum wholly covered with small punctures.

Propodeum with basal triangle defined by a shallow depression; median carina complete to upper part of declivity, transverse carina not distinguishable from the transverse striations. Mesopleura wholly covered with small punctures. Claws dentate, tooth short and suberect. Wings with discoidal cell fully outlined by pigmented lines; radial, cubital, and subdiscoidal veins nearly reaching wing margin as pigmented streaks; first recurrent vein evident as a pigmented streak; pale streaks on outer part of wing (following courses of obsolete veins) unusually conspicuous because of the dark wing membrane. Subgenital plate truncate apically. Genitalia (Fig. 20) with the lateral elements about as in the preceding several species, but with the tip of the aedoeagus conspicuously bulbous, with a small dorsal tubular element between the lateral lobes and extending beyond the apices of the middle valves.

Paratypes. — CHIHUAHUA: 2 ♂♂, same data as type except one taken by M. A. Cazier [AMNH, MCZ]; 1 ♂, Santa Barbara, 6200 feet, 17 Aug. 1947 (G. M. Bradt) [AMNH]; 1 ♂, 63 mi. W. Santa Barbara, 5500 feet, 20 July 1947 (W. J. Gertsch); 2 ♂♂, Valle de Olivos, 5500 feet, 20 July 1947 (C.D. Michener) [AMNH]. ZACATECAS: 1 ♂, 2 mi. S. Fresnillo, 16 July 1954 (MacSwain and Schlinger) [CIS]. ARIZONA: 1 ♂, Mustang Mts., Santa Cruz Co., 30 July 1941 (R. H. Beamer) [KU]; 1♂, Douglas, Cochise Co., 15 Aug. 1936 (W. W. Jones) [USNM].

Variation. — The largest paratypes, those from 63 mi. W. of Santa Barbara, and one of those from Valle de Olivos, Chihuahua (LFW about 8.5 mm.), have the wings slightly paler than in the type. The second Valle de Olivos specimen is striking in that the wings are subhyaline and the mandibles have a small fifth tooth (about as in Fig. 33), even though in all other paratypes the mandibles are 4-toothed (Fig. 35). The smallest specimen, that from Douglas, Ariz. (LFW 6.6 mm.) has the punctures of the head and thorax slightly weaker than in the type. The specimen from the Mustang Mts., Ariz., although a large one (LFW 8.2 mm.), has the punctures very small and shallow, particularly on the vertex and upper part of the front; the latter are strongly polished and almost impunctate. This specimen and three of those from Chihuahua lack hairs on the eyes, presumably because they have been rubbed off.

Female — Unknown.

17. Pristocera (Acrepyris) rugifrons (Cameron)

Epyris rugifrons Cameron, 1888, Biol. Centr.-Amer., Hymen. I, p. 449, pl. 19, fig. 12. [Type: ♂, GUATEMALA: Las Mercedes, 3000 feet (G. C. Champion) (BMNH)].

Pristocera rugifrons Kieffer, 1908, Genera Insect., 76: 22. —Kieffer, 1914, Das Tierreich, 41: 467-468.

Description of type. — Length 9 mm.; LFW 6.3 mm. Head and thorax black; abdomen, legs, and antennae very dark brown; wings lightly infuscated, veins and stigma brown. Body hairs whitish. Mandibles with four teeth, with a wide gap between the basal two teeth (as in Fig. 35). Clypeus with a broadly V-shaped apical emargination; median carina strong. First four antennal segments in a ratio of about 26:5:20:18, segment three 2.5 X as long as thick, segment eleven 4 X as long as thick; pubescence whitish, semi-erect, setulae of segment eleven .25 X as long as width of segment; basal flagellar segments somewhat flattened, obscurely serrate in profile. Eyes with a few short hairs above. Front with a median groove in front of anterior ocellus, with coarse, contiguous punctures on sides and below, impunctate just in front of and behind ocellar triangle. WH 1.08 X LH; inner orbits converging below, WF .56 X WH, 1.25 X HE. Ocelli in a compact triangle, the front angle very slightly less than a right angle; WOT .75 X OOL. Vertex broadly rounded off a distance above eye tops equal to about .7 X HE. Pronotum very short, depressed along posterior margin, coarsely punctate. Mesoscutum polished, almost impunctate between notauli; scutellar disc covered with small punctures. Propodeal disc with the basal triangle limited by a shallow depression, filled with irregular carinae; median carina incomplete on basal half, then continuing irregularly to lower portion of declivity; postero-lateral portions of disc with weak, irregular transverse striae. Mesopleura polished, weakly punctate. Claws bifid, inner ray broad, truncate, subparallel to outer ray (Fig. 58). Fore wing with discoidal cell closed, first recurrent vein distinct, radial and subdiscoidal veins continued to outer wing margin as faint pigmented streaks. Subgenital plate weakly emarginate medially. Genitalia (Fig. 19) resembling closely those of *varidens* and *tenochca*, differing chiefly in minor details of the middle and dorsal valves of the aedoeagus.

Remarks. — Cameron's statement that the body hairs of this species are fuscous is incorrect; they are whitish as in other species of the genus. Nor are the wings fuscous, as he describes and figures them, but merely lightly tinged with fuscous. Also

the apex of the abdomen is not "red," but simply weakly suffused with brownish.

Female. — Unknown.

18. Pristocera (Acrepyris) palliditarsis (Cameron) new combination

Epyris palliditarsis Cameron, 1897, Ann. Mag. Nat. Hist., (6)19: 274. [Type: ♂, MEXICO: TABASCO: Teapa, March (H. H. Smith) (BMNH)]. —Cameron, 1899, Biol. Centr.-Amer., Hymen. I, Suppl., p. 473.

Description of type. — Length 10 mm.; LFW 7.5 mm. Body entirely black; mandibles black, dark rufous apically; antennae black; legs black except basal two segments of middle and hind tarsi conspicuously whitish; fore wing hyaline on basal half except somewhat infuscated along veins, apical half distinctly tinged with brown, especially strongly so just below and beyond stigma; hind wings hyaline, weakly infuscated apically. Body hairs whitish. Mandibles with five teeth, the fourth tooth very much smaller than the others. Clypeus with its apical margin weakly concave, median carina weakly arched in profile. First four antennal segments in a ratio of about 30:6:19:18, segment three 2.5 X as long as thick, segment eleven 3.8 X as long as thick; pubescence pale, suberect, setulae of segment eleven .4 as long as width of segment. Front polished, coarsely punctate, the punctures subcontiguous in longitudinal series, the interspaces forming irregular round-topped ridges; vertex and temples with the punctures well separated. Eyes with sparse, short setae on upper part. Head very broad, WH 1.10 X LH; inner orbits strongly convergent below, WF .53 X WH, 1.10 X HE. Ocelli in a compact triangle, front angle less than a right angle; WOT .77 X OOL. Vertex rather narrowly rounded off a distance above eye tops equal to about .6 X HE. Pronotum short, coarsely punctate, with some irregular transverse rugae just before the subapical depression. Mesoscutum polished, covered with strong punctures which are more widely spaced medially than on the sides; notauli not quite attaining posterior margin; scutellar disc strongly punctate. Propodeal disc with basal triangle large, coarsely reticulate, bordered by carinae flanking a shallow depression; median carina attaining the relatively strong transverse carina; postero-lateral portions of disc with moderately strong, rather irregular sculpturing. Mesopleurum covered with large punctures except callus weakly punctured. Claws

bifid, inner ray broader than outer ray and of about the same length (as in Fig. 56). Fore wing with the discoidal cell strongly outlined, subdiscoidal vein strong all the way to outer wing margin, first recurrent vein weakly indicated. Subgenital plate truncate apically. Genitalia (Fig. 27) of striking form, particularly the aedoeagus, which has both ventral and middle valves very short and not overlapping, the dorsal valves broadly expanded apically, with thin, unpigmented flanges which extend laterad and are surpassed by the pigmented median lobes.[2]

Other males examined. — One, PANAMA: Bugaba (G. C. Champion) [BMNH].

Variation. — The Panama specimen is smaller (LFW 5.8 mm.) and has less white on the tarsi: only the basal segments of the middle and hind tarsi are whitish, and these only on the basal three-fourths. In this specimen the antennae are longer and have slightly longer setulae; segment eleven measures nearly 5 X as long as thick, and bears setulae which are about half as long as the width of the segment. In other respects the resemblance to the type is very close.

Female. — Unknown.

19. Pristocera (Acrepyris) sinaloa new species

Holotype. — ♂, MEXICO: SINALOA: Venedio, 17 June 1918 (E. C. VanDyke) [CAS].

Description of type. — Length 9.5 mm., LFW 6.7 mm. Head and thorax black, abdomen dark reddish-brown; mandibles dark reddish-brown apically; flagellum brown; legs dark brown except tarsi light yellowish-brown; wings subhyaline except fore wing distinctly clouded on apical third, more intensely so anteriorly, in and just below radial cell. Erect hairs of head and thorax whitish, moderately dense. Mandibles with five teeth, fourth tooth smaller than the others, lower mandibular margin arched (much as figured for *cockerelli*, Fig. 32). Clypeus with a broadly V-shaped apical emargination; median carina not arched in profile. Antennae with first four segments in a ratio of about 30:5:19:18, segment three 2.2 X as long as thick, segment eleven 3.2 X as long as thick; flagellar segments not at all thickened apically; pubescence light brown, suberect, setulae of segment eleven about one-fourth as long as thickness of segment, each

[2] The description and figure of the genitalia are based on the specimen from Panama, the genitalia of the type not having been extracted.

flagellar segment (but especially more basal segments) also with a few erect setulae which are about twice as long as pubescence. Eyes with some weak, short hairs on upper part. Head polished, strongly punctate; punctures of front and to some extent of temples subcontiguous in irregular longitudinal rows, those of vertex well separated. Front relatively narrow, WF .56 X WH, 1.2 X HE; ocelli in a small triangle, front angle less than a right angle, WOT .72 X OOL and considerably less than distance from hind ocelli to vertex crest. Pronotum with sides and anterior face strongly polished, disc strongly punctate, without rugae but with a strong transverse apical depression. Mesoscutum with notauli strong and complete, space between notauli with only a few punctures but sides strongly punctured; scutellum sparsely punctured. Propodeal disc with basal triangle set off by a shallow depression bordered by weak carinae; median carina moderately well developed, reaching the rather strong transverse carina bordering the declivity; sculpturing of disc rather irregularly reticulate. Mesopleurum with strong, close punctures. Claws with the middle tooth long, actually thicker than the outer tooth (Fig. 56). Fore wing with the discoidal cell closed by weak veins, radial, cubital, and subdiscoidal veins extending nearly to wing margin as weakly pigmented streaks. Abdomen stout, shining. Subgenital plate weakly emarginate, about as figured for *armifera* (Fig. 5). Genitalia (Fig. 28) much like those of *pallidifarsis* but parameres somewhat more slender and more curved apically, aedoeagus with lateral apical flanges complex and extending beyond median lobes.

Female. — Unknown.

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PLATES

PLATE 1

Fig. 1. Male genitalia, ventral aspect, of *Pristocera* (*Pristocera*) ***depressa*** (Fabr.)

Fig. 2. Same of *P.* (*Acrepyris*) *oriplana* Kieffer

Fig. 3. Same of *P.* (*A.*) *japonica* Yasumatsu

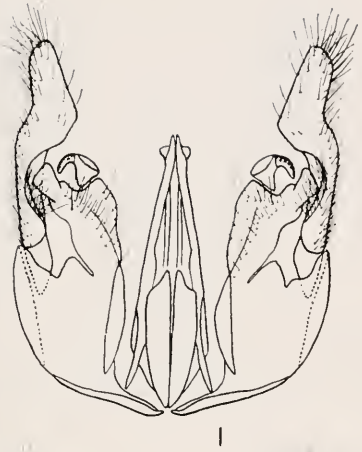
Fig. 4. Same of *P.* (*A.*) *erythropoda* (Cameron)

Fig. 5. Male subgenital plate of *P.* (*A.*) *armifera* (Say)

Fig. 6. Same of *P.* (*A.*) *californica* n. sp., paratype

Fig. 7. Same of *P.* (*Pristocera*) *depressa* (Fabr.)

Fig. 8. Same of *P.* (*Acrepyris*) *nebulosa* n. sp., holotype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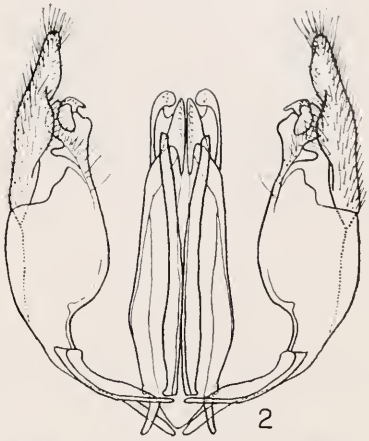
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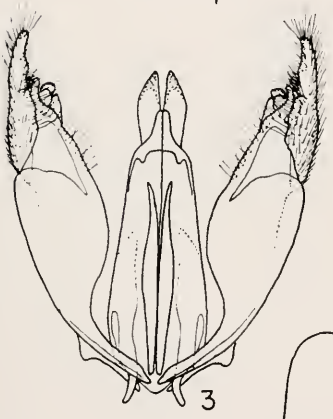
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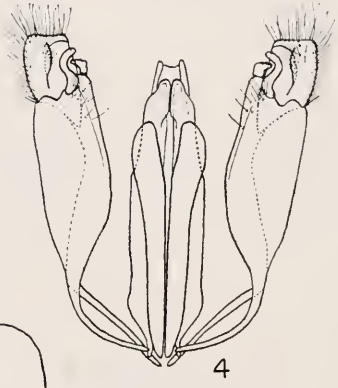
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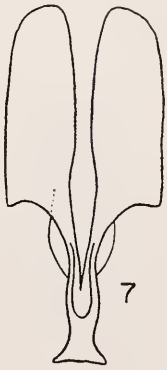
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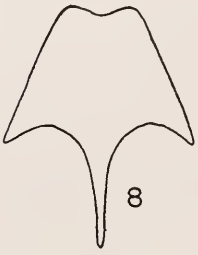
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PLATE 2

Fig. 9. Male genitalia, ventral aspect, of *Pristocera* (*Acrepyris*) *armifera* (Say)

Fig. 10. Same of *P.* (*A.*) *cockerelli* n. sp., holotype

Fig. 11. Same of *P.* (*A.*) *bridwelli* n. sp., holotype

Fig. 12. Same of *P.* (*A.*) *atra* Klug

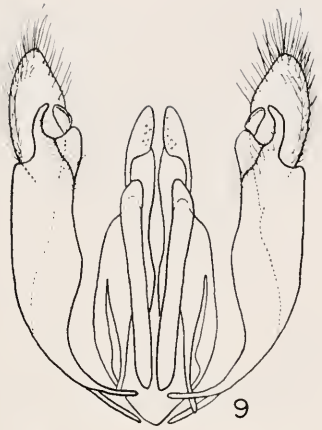
Fig. 13. Lateral aspect of paramere of *P.* (*A.*) *armifera* (Say)

Fig. 14. Same of *P.* (*A.*) *fraterna* n. sp., holotype

Fig. 15. Ventral aspect of paramere of *P.* (*A.*) *fraterna* n. sp., holotype

Fig. 16. Lateral aspect of paramere of *P.* (*A.*) *californica* n. sp., paratype

Fig. 17. Same of *P.* (*A.*) *atra* Klug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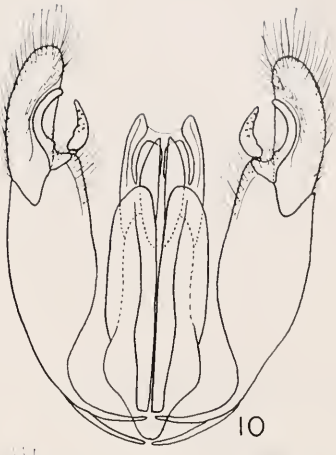
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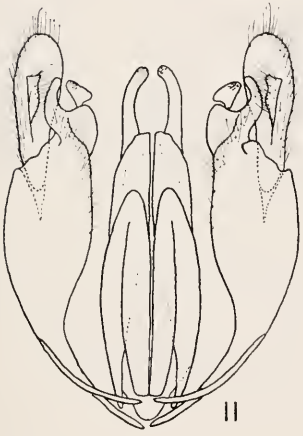
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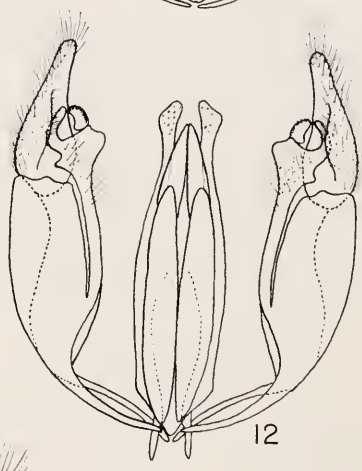
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PLATE 3

Fig. 18. Male genitalia, ventral aspect, of *Pristocera* (*Acrepyris*) *hyalina* Brues

Fig. 19. Same of *P.* (*A.*) *rugifrons* (Cameron), holotype

Fig. 20. Same of *P.* (*A.*) *chihuahua* n. sp., paratype

Fig. 21. Same of *P.* (*A.*) *nebulosa* n. sp., holotype

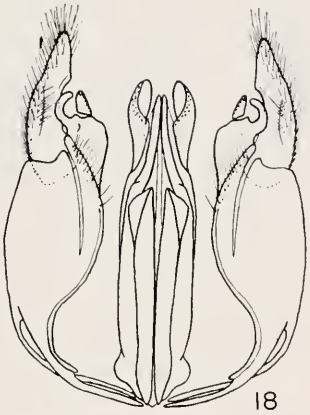
Fig. 22. Lateral aspect of paramere of *P.* (*A.*) *orizabae* (Cameron), holotype

Fig. 23. Same of *P.* (*A.*) *nebulosa* n. sp., holotype

Fig. 24. Same of *P.* (*A.*) *oriplana* Kieffer

Fig. 25. Same of *P.* (*A.*) *hyalina* Brues

Fig. 26. Same of *P.* (*A.*) *rugifrons* (Cameron), holotype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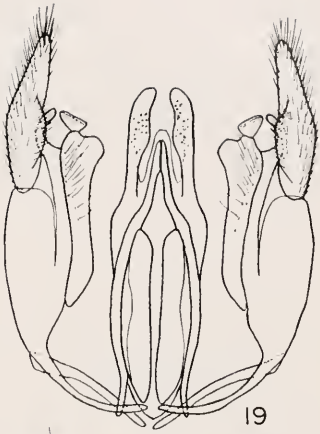
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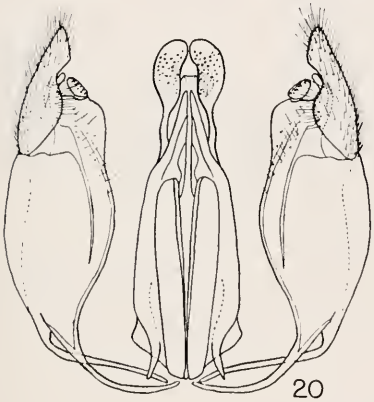
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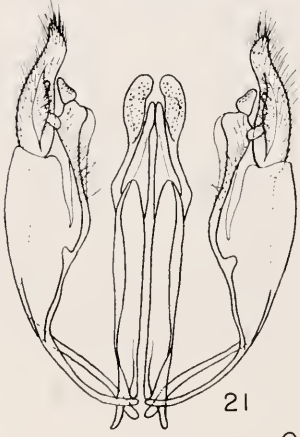
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PLATE 4

Fig. 27. Male genitalia, ventral aspect, of *Pristocera* (*Acrepyris*) *pallidi-tarsis* (Cameron)

Fig. 28. Same of *P.* (*A.*) *sinaloa* n. sp., holotype

Fig. 29. Same of *P.* (*A.*) *otomi* n. sp., holotype

Fig. 30. Aedoeagus of *P.* (*A.*) *orizabae* (Cameron), ventral aspect

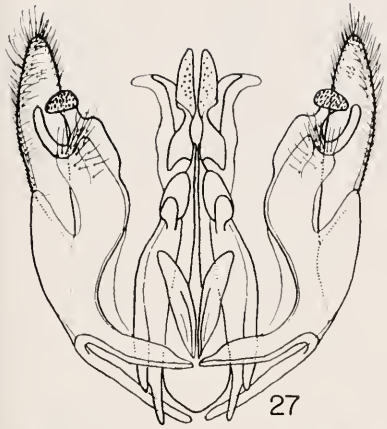
Fig. 31. Aedoeagus of *P.* (*A.*) *oriplana* Kieffer, lateral aspect (see Fig. 2 for ventral aspect). In this figure the dorsal valves, on the left side, are seen hooking over and embracing the middle valves, which are hooked dorsad.

Fig. 32. Mandible of male *P.* (*A.*) *cockerelli* n. sp., holotype

Fig. 33. Mandible of male *P.* (*A.*) *fraterna* n. sp., holotype

Fig. 34. Mandible of male *P.* (*A.*) *californica* n. sp., paratype from South Pass, Wyoming

Fig. 35. Mandible of male *P.* (*A.*) *chihuahua* n. sp., holotype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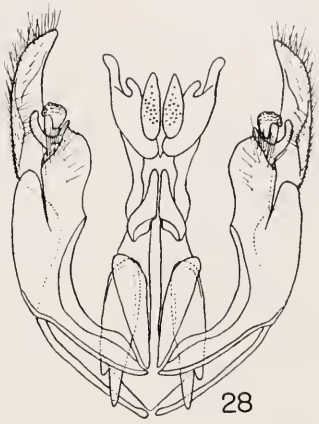
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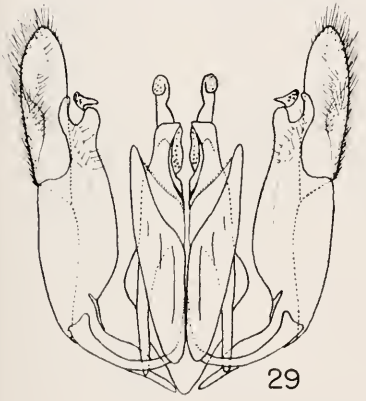
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PLATE 5

Fig. 36. Aedoeagus of *Pristocera* (*Acrepyris*) *varidens* (Cameron), ventral aspect

Fig. 37. Same of *P.* (*A.*) *tenochca* n. sp., holotype

Fig. 38. Same of *P.* (*A.*) *intermedia* n. sp., holotype

Fig. 39. Same of *P.* (*A.*) *cockerelli* n. sp., paratype from San Antonio, Texas

Fig. 40. Same of *P.* (*A.*) *fraterna* n. sp., holotype

Fig. 41. Same of *P.* (*A.*) *californica* n. sp., paratype

Fig. 42. Dorsal view of pronotal disc of male *P.* (*A.*) *armifera* (Say)

Fig. 43. Same of *P.* (*A.*) *fraterna* n. sp., holotype

Fig. 44. Same of *P.* (*A.*) *tenochca* n. sp., holotype

Fig. 45. Same of *P.* (*A.*) *hyalina* Brues

Fig. 46. Same of *P.* (*A.*) *orizabae* (Cameron), holotype

Fig. 47. Same of *P.* (*A.*) *rugifrons* (Cameron), holotype

Fig. 48. Segments 5-7 of antennae of male *P.* (*A.*) *atra* Klug, lateral aspect

Fig. 49. Same of *P.* (*A.*) *chihuahua* n. sp., holotype

Fig. 50. Same of *P.* (*A.*) *hyalina* Brues

Fig. 51. Same of *P.* (*A.*) *cockerelli* n. sp., holotype

Fig. 52. Mandible of female *P.* (*A.*) *armifera* (Say)

Fig. 53. Mandible of female *P.* (*A.*) *atra* Klug

Fig. 54. Mandible of male *P.* (*A.*) *atra* Klug

Fig. 55. Hind tarsal claw of male *P.* (*Pristocera*) *depressa* (Fabr.)

Fig. 56. Same of *P.* (*Acrepyris*) *sinaloa* n. sp., holotype

Fig. 57. Same of *P.* (*A.*) *erythropoda* (Cameron)

Fig. 58. Same of *P.* (*A.*) *rugifrons* (Cameron), holotype

Fig. 59. Same of *P.* (*A.*) *nebulosa* n. sp., holotype

Fig. 60. Same of *P.* (*A.*) *armifera* (Say)

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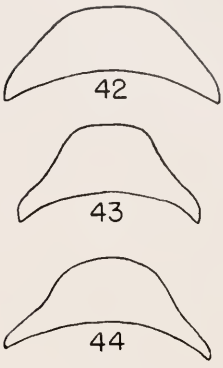
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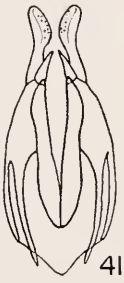
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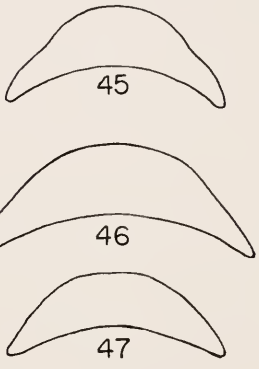
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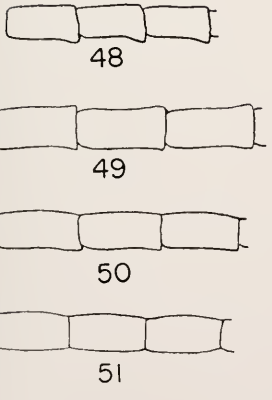
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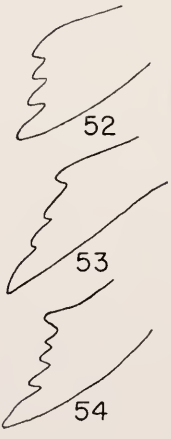
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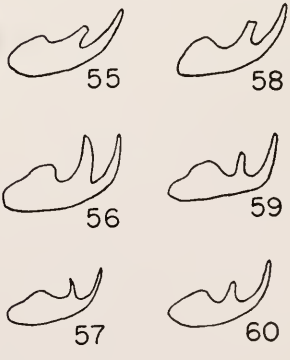
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Bulletin of the Museum of Comparative Zoology

AT HARVARD COLLEGE

Vol. 129, No. 5

THE HERPETOLOGY OF THE PORT-AU-PRINCE REGION AND GONAVE ISLAND, HAITI. PARTS I-II

By

Ernest E. Williams,

Benjamin Shreve,

and

Philip S. Humphrey

With Five Plates

CAMBRIDGE, MASS., U.S.A.

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Part I. The Region, The Expeditions and The Collections.

By Ernest E. Williams
Museum of Comparative Zoology

and

Philip S. Humphrey
United States National Museum

INTRODUCTION: THE REGION.

A very substantial collection of amphibians and reptiles from the Port-au-Prince region, the Fôret des Pins and Gonave Island, Haiti, made in early 1959 by P. S. Humphrey then of Peabody Museum, Yale University, proved so interesting when borrowed by E. E. Williams, of the Museum of Comparative Zoology, Harvard University, that a ten-day visit to the Port-au-Prince area was undertaken by E. E. Williams and A. S. Rand in August,

1959, with a view to supplementing the original collection in certain aspects. Additional material was collected for Peabody Museum and the Museum of Comparative Zoology in May, 1960, and later by M. Luc Whiteman. Still other specimens were obtained by A. S. Rand and J. Lazell in July, 1960, incidental to an expedition to other regions of the republic.

These collections, despite their size, deal with a limited area of the Republic of Haiti (Fig. 1) which is itself the smaller fraction of the island of Hispaniola. It so happens that in the years intervening between 1940 and the present, the Haitian collections of the United States National Museum, the American Museum and the Museum of Comparative Zoology have been enriched by material collected by Anthony Curtiss, whose area of investigation was again the general Port-au-Prince region.

It is therefore logical to survey at this time the fauna of this relatively well known area.

It is necessary, however, to admit at once that the area has no natural borders and must be defined in a measure by convenience. There are three subregions within it: 1. *The hills and*

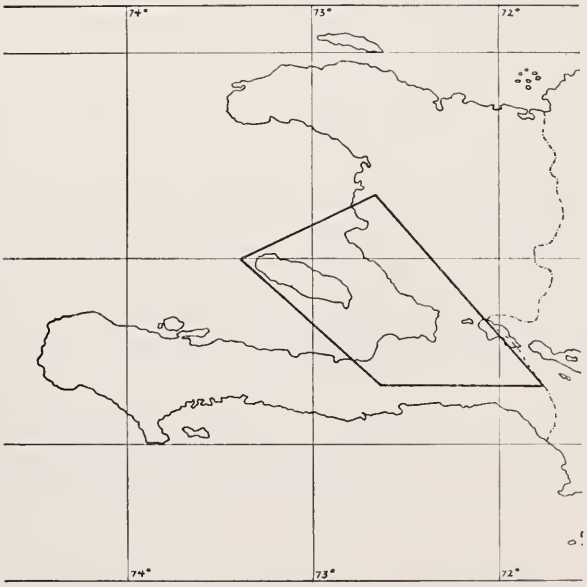

Fig. 1. The Port-au-Prince region and Gonave Island, Haiti. The quadrilateral shows the arbitrary boundaries of the area discussed in this series of papers.

mountains south and southeast of Port-au-Prince. The eastern edge here is determined by a political boundary, the border of the Dominican Republic, the western edge by the falling off of the Massif de la Selle to the west into the lower ridges that connect it with the Massif de la Hotte. To the south we omit discussion of the almost unknown southern slopes of the Massif de la Selle. To the north the limit is a natural one — our second subregion.

2. *The Cul de Sac Plain and the arid coast.* Again the eastern boundary is a political one. The northern border is in part a natural one — the low mountains that are the southern border of the valley of the Artibonite — but at the west coast the physical features, flora and fauna of the Cul de Sac continue without any natural break into the dry coastal zone stretching toward the north. We arbitrarily choose the Artibonite River where it is met by the St. Marc-Cap Haitien road as the northwesternmost limit of our regon. The coastal zone of Haiti south of the Cul de Sac Plain is not nearly so dry; it is not so clearly a continuation of the Cul de Sac area; it is also almost uncollected. We arbitrarily set the SE limit of this zone at Leogane.

3. *Gonave Id.* This island, which is a disjunct portion of the Cul de Sac Plain, has at least natural boundaries. It is also, in terms of its fauna, a rather distinct subregion.

Despite the partial arbitrariness of its definition, the Port-au-Prince region and Gonave form a fortunate area for study in several respects.

1. This is an area in which sharp ecological-climatic changes occur within a very few miles. Indeed, it exhibits within itself the three major ecological-climatic zones of Haiti: (a) the arid, hot lowlands; (b) the temperate pine forest of the high mountains which, though inside tropical latitudes, does regularly incur frost;[1] (c) the areas between these, intermediate in elevation and temperature, and differing from both in elements of flora and fauna. We shall have much to say about the zonation of faunas.

2. This is an area that at some times has included the island of Gonave and that at other times has been broken into by the sea. An arm of the sea once filled the Cul de Sac Plain, dividing

1 Dense patches of hardwoods occur within the pine zone. These provide a habitat very different from the more open pine, and P. J. Darlington has emphasized to us that most of the endemic Hispaniolan carabids occur exclusively or almost exclusively within this "cloud forest." Perhaps this temperate hardwood forest should be distinguished as a separate zone, but at the present time and in Haiti it is so limited and so nearly destroyed that its herpetological fauna is unknown to us and we will therefore not discuss it separately here.

Hispaniola into two islands. Remnants of the sea still exist in the saline lakes within the Plain — the Étang Saumâtre at the Haitian-Dominican border and Lake Enriquillo in the Dominican Republic. Indeed, the shallow waters that divide Gonave Island from the Cul de Sac Plain are reminders that the oceans are higher now than they were during part of the Pleistocene. The effects of these changes in sea level upon the fauna are of great interest. The discussion of these effects, however, must be part speculative but yet there are important bits of evidence from the herpetofauna.

3. This is an area which spans the only clear physiographic division of Hispaniola. The arm of the sea, which once occupied the Cul de Sac Plain, by the fact of its existence divided Hispaniola into two islands and thus into two theatres of evolution. This separation has been, for the evolution of many Hispaniolan species, a primary factor in their origin and history. We shall have many occasions to refer to this point.

4. This is an area much altered by man. The extent to which the faunas have held their ground or have altered their positions is a point worth much further investigation. It is the aspect on which our evidence is least adequate, but we shall need to discuss it.

Even prior to the most recent expeditions, the Port-au-Prince area, as the usual first port of call in Haiti, has had at least casual study. In spite of this the novelties and new data obtained in 1959-1960 in this relatively well known area reinforce Miss Cochran's observation made in 1940, that "undoubtedly a great many more species and perhaps even some genera remain to be discovered in areas in which little collecting has so far been done."

Along with new taxonomic data has come much information on the ecology, habits and colors in life of species heretofore known only as museum specimens. This new knowledge permits recognition of a rough division of the Haitian herpetofauna into three faunal subunits — a fauna specialized to very dry conditions, a fauna endemic to the high mountains, and a third ecologically intermediate fauna, usually less specialized and capable of adaptation to very disturbed conditions.

The new information, though considerable in amount, by no means permits a resurvey of Hispaniolan herpetology. The restricted area of attention of the present series of papers in part reflects the limited area of collection of the most recent expeditions, but it also reflects a feeling that any attempt at a wider

study at this time would necessarily be inadequate and not useful. Quite simply, too much remains to be learned. *Hence this series of papers is intended as a supplement to and not a substitute for Cochran's "Herpetology of Hispaniola."* We shall constantly refer to the latter; we do not include full descriptions of any but new forms, nor do we attempt the solution of any problems that are *primarily* extralimital.

Hispaniola has turned out, we must emphasize, to be more complex than was implied by even Miss Cochran's cautionary remark above (overlooked, we believe, by most of her readers). The materials not only did not exist when Miss Cochran wrote,[1] the materials do not *now* exist for an adequate, much less a definitive, knowledge of the herpetology of Hispaniola. Differentiation is finer grained, ecology vastly more significant than earlier students (or ourselves at first) supposed. In Barbour's time, under the influence of his sanguine psychology and powerful personality, it was usual to assume that the fauna of a West Indian island could be sampled and described from the booty of a few relatively casual collections. Nowhere is this conception further from the truth than in Hispaniola.

EXPEDITIONS AND ACKNOWLEDGMENTS

1. *The Yale-Florida Expedition:*

Humphrey collected reptiles, amphibians, and birds in Haiti during February, March, and April, 1959, under the combined auspices of the University of Florida Zoology Department, the Florida State Museum, the Yale University Peabody Museum of Natural History, and the Pan-American Section of the International Council for Bird Preservation. The generous support of these institutions is gratefully acknowledged. Humphrey is particularly indebted to Dr. J. C. Dickinson, Jr., Director of the Florida State Museum, for arranging a temporary appointment to the Florida State Museum staff as Interim Assistant Curator. Dr. Dickinson's initial interest in and subsequent wholehearted support of Humphrey's proposed trip to Haiti not only made the trip possible but also contributed in large measure to its success. Humphrey is grateful for the important additional support received from Mrs. Milton Erlanger.

1 The Noble and Hassler material which Miss Cochran did not see does not invalidate this statement. There are specimens from regions (e.g., Barahona) for which Miss Cochran's samples were deficient and there are huge series from occasional localities, but the coverage of the island was considerably less than satisfactory and many specimens have lost their data or are abominably preserved.

The herpetological collections made during Humphrey's sojourn in Haiti would not have been possible without the invaluable assistance of Sarita Van Vleek, Technical Assistant in Herpetology, Yale Peabody Museum of Natural History. Miss Van Vleek participated actively in all phases of the field work in Haiti; her most important contribution is undoubtedly the careful color notes she recorded from healthy, living specimens.

Various agencies and people in the government of Haiti took great interest in the field projects and provided permits to travel anywhere in the country, and assisted with transportation, housing, and in countless other ways in the various practical details of the field work. The expedition was particularly indebted to M. Henri Marc-Charles, formerly Minister of Agriculture and Natural Resources, and to his staff for providing the initial permission for the field work, for arranging for all the necessary documents, and for providing the essential authorizations from other governmental agencies. Gratitude is due to M. Gerard Philippeaux, present Minister of Agriculture for continuing to provide all the courtesies of his office. M. Leonce Bonnefil Fils, Zoologist in the Department of Agriculture and Natural Resources, became a valued friend and in this capacity assisted far more than his official status required. Many other friends helped in ways too numerous to list; the following people and agencies in particular are thanked for their many kindnesses: M. "Bi-Bi" Chandler, Dr. Gerald Gros, Dr. Sidney Mintz, Mme. Catherine Dunham, M. Georges Renaud, M. Albert Mangonés, M. and Mme. Gesner Phénestor, M. Casseliodor St. Jules, M. Luc Whiteman, M. Roger M. Constant, Madame Jean Brierre, and the many nameless people young and old who brought in specimens. The officials of the Société Haitiano-Americaine de Developpement Agricole (SHADA), ICA, the Police, and the Army gave generous assistance without which the work would have been impossible.

We are grateful to Dr. S. Dillon Ripley, 2nd, Director of the Yale Peabody Museum of Natural History for advice and assistance with various phases of this project.

2. *The Harvard Expedition:*

Williams and Rand collected reptiles and amphibians from August 6-15, 1959. Prior arrangements were made by Humphrey by correspondence. M. Gerard Philippeaux provided a letter of introduction which was an open sesame to all the areas it was desired to visit. M. Leonce Bonnefil Fils was extraordinarily helpful at every phase of the investigation. M. Luc Whiteman

assisted us in the field as did M. E. Rowe. The Pension Tourdot accepted the establishment of a laboratory for the preservation of reptiles and amphibians on its back porch with equanimity. National Science Foundation Grant NSF-G5634 furnished the funds for this investigation of the Haitian fauna as part of a more general investigation. Lastly, the friendly cooperation of the Haitian people everywhere cannot be too highly praised.

OTHER COLLECTIONS

For the privilege of examining much unreported material collected by Anthony Curtiss we are indebted to Dr. Doris Cochran of the United States National Museum and to Charles M. Bogert of the American Museum of Natural History. To the latter we are also indebted for the opportunity to study the large Hispaniolan collection amassed by Noble and Hassler during the 1930s and never fully described. We have recorded pertinent specimens from the Port-au-Prince area and utilized the extralimital material wherever it was significant for taxonomic or distributional problems. In the same fashion we have used collections made for the Museum of Comparative Zoology in 1958 by Clayton E. Ray and A. S. Rand in the Dominican Republic, with the generous help of the Dominican Government, the Universidad de Santo Domingo, and of Professor Eugenio de Jesus Marcano, and the partial support of a grant from the Society of Sigma Xi. We have similarly benefited from study of the collection made in northern and southwest Haiti by A. S. Rand and J. Lazell with the aid of a grant from the American Philosophical Society and with the characteristic help of the Haitian Government and people. We are indebted also to Dr. Robert Inger of the Chicago Museum of Natural History and to Dr. Norman Hartweg of the Museum of Zoology, University of Michigan, and to Dr. Philip Smith of the Illinois Natural History Survey for material borrowed from collections under their care. National Science Foundation Grant NSF G-16066 has furnished funds for additional and still continuing collecting in Haiti.

NOTES AND FIELD OBSERVATIONS: HASSLER, CURTISS.

For pertinent observations dealing with the Port-au-Prince region we have utilized the notebooks of W. G. Hassler preserved in the American Museum. For the privilege of doing so we are indebted to Mr. C. M. Bogert.

A special store of very perceptive and accurate field observations on the herpetofauna of the Port-au-Prince region exists in the letters written by Anthony Curtiss to Dr. Doris Cochran in the years 1942-1950. Much that the recent expeditions rediscovered was set down by him years before, along with details available nowhere else. As an amateur naturalist resident in the region, he had unrivalled opportunities for field study and used them well. We are grateful to Dr. Doris Cochran for permission to examine this correspondence.

COLLECTING DATES AND METHODS

Humphrey's herpetological collections were made at the following localities:

Port-au-Prince: Pont Morin (5 days); Carrefour: Dunham Estate (1 day); Forêt des Pins (11 days); Île de la Gonave: Nan Café (15 days); Île de la Gonave: Pointe-à-Raquette (3 days); D'Leau Gaillée (3 days); Petionville (small collections made by native boys).

Collecting techniques varied in the several localities. Humphrey and Van Vleck captured all specimens taken at Pont Morin, Carrefour, and the Forêt des Pins. No success was had in attempts to interest the residents of the Forêt des Pins in collecting. With native help a more representative collection could have been made in that region.

At Nan Café, Pointe-à-Raquette, and D'Leau Gaillée it was possible to purchase specimens in abundance. Even small amounts of money paid for specimens in these areas proved such an attraction to the local people that they brought in huge quantities of material of all kinds. It was found that by varying the prices for different kinds of animals and by requiring that all specimens be alive and undamaged, great numbers of perfect specimens could be obtained relatively easily. The only disadvantages of this method were that, e.g. in the Nan Café area, there was no way of knowing whether the specimens had been captured at Nan Café or at Grand Source, a mile or so away, and there was also no way of knowing the ecological situation in which each of the animals was captured.

Williams and Rand visited Haiti August 6 to August 15, 1959. Herpetological collections were made at the following localities: Pont Morin, Port-au-Prince, Furcy (3 days), Basin Bleu (a short excursion from Furcy), Obleon (roadside stop), Kenskoff, Boutillier Road (several visits), Carrefour (short visit), Damien

(1 day), Delmas (1 afternoon), St. Marc, Carrefour la Morte, Bois de Chenes, S end of Etang Bois Neuf, Pierre Paien (roadside stops), Artibonite Bridge (2 days), road to D'Leau Gaillée, D'Leau Gaillée, Thomazeau, between Thomazeau and Manneville, Manneville (2 days).

Part II. The Frogs

By Benjamin Shreve
and
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INTRODUCTION

We record below all frogs known from the Port-au-Prince region, as we have defined it, and in addition one other probable species. Two new species and one new subspecies are described, raising to 17 the total of known taxa, 12 of them *Eleutherodactylus*, the probable total to at least 18.

There are marked differences in altitudinal occurrence. All strictly highland forms are *Eleutherodactylus*. Table 1 below shows this very clearly.

Ecological and life history information on all of these forms is, as yet, extremely meager. Very little information on voices is available.[1] Only in the case of *E. inoptatus* are the eggs of the eleutherodactyli commonly collected. All the hylas are known to breed in open water (basins alongside mountain streams, marshy areas or ponds). In contrast to Jamaica, no frogs are known to be characteristic of or to breed in bromeliads. Humphrey and Van Vleck examined many bromeliads in the Forêt des Pins, which contained little or no water and were apparently not used by frogs.

The material forming the basis of the detailed discussion which follows is lodged in the following institutions: American Museum of Natural History (AMNH), Carnegie Museum (CM), Illinois Natural History Survey (INHS), Museum of Comparative Zoology (MCZ), University of Florida collections (UF), United States National Museum (USNM), Yale Peabody Museum (YPM).

1 The information collected by Noble on these points (for Dominican not Haitian frogs) was never published in full. Some of it can be extracted from his papers of 1923, 1925, 1927 and 1929.

Table 1

Frogs of the Port-au-Prince region

	Port-au-Prince and neighboring hills (to 1000 ft.)	La Selle Range: Furcy (4000-5000 ft.)	La Selle Range: La Selle and Forêt des Pins (5000-7000 ft.)
Bufo marinus	X (introduced)	—	—
güntheri	X	—	—
Hyla pulchrilineata	X (island wide)	—	—
heilprini	—	X (island wide)	—
dominicensis	X (island wide)	—	—
vasta	—	X (island wide)	—
Eleutherodactylus			
inoptatus	X (island wide)	X	—
varians wetmorei	X	—	—
pictissimus	X	X	—
abbotti audanti	X ?	X	X
bakeri heminota			
subsp. n.	—	X	—
semipalmatus	—	X	—
armstrongi	—	X	X
furcyensis sp. n.	—	X	X
darlingtoni	—	—	X
leoncei sp. n.	—	—	X
jugans	—	—	X
glanduliferoides	—	—	X

Key to the Frogs of the Port-au-Prince region and Gonave Island

1. Parotoid glands present. *Bufo* 2
   Parotoid glands absent 3
2. Parotoid glands very large, elongate; warts evenly distributed over back. . . . *Bufo marinus.* Very large: size to at least 160 mm.[1]
   Parotoid glands relatively small; warts densely concentrated on anterior of back. . . . *Bufo güntheri.* Large: size to 94 mm. (Lynn, 1958).
3. Feet well webbed; hands show at least some webbing. *Hyla* 4
   Feet unwebbed or webbed at base; hands unwebbed ..... *Eleutherodactylus* 7
4. Hands extensively webbed 5
   Hands not extensively webbed 6
5. Projecting prepollex. Bright yellow and green in life. . . . *Hyla heilprini.* Size to 53 mm. (MCZ 34181).
   No projecting prepollex; a dermal fringe on outer borders of limbs. Mottled gray and dark gray in life. . . . *Hyla vasta.* Very large: size to 142 mm.
6. Skin of head not involved in cranial ossification; light longitudinal lines on body and hind limbs (sometimes obscure). Never mottled; brown or green in life with yellow lines. . . . *Hyla pulchrilineata.* Small: size to 43 mm. (Lynn, 1958).
   Skin of head involved in cranial ossification; no light longitudinal lines on body and hind limbs. Gray or green or light brown, at least vaguely mottled. . . . *Hyla dominicensis.* Large: size to 99 mm. (MCZ 22482).
7. A spinelike tubercle on upper eyelid; size, large, to 88 mm. ..... *Eleutherodactylus inoptatus.*
   No spinelike tubercle on upper eyelid; size smaller 8
8. Feet distinctly webbed at base, the web extending as a distinct fringe on the sides of the digits; size small, to 28 mm. . . . *Eleutherodactylus semipalmatus.*
   Feet not distinctly webbed at base, the web not extending as a distinct fringe on the sides of the digits 9
9. Short dorsolateral folds; venter granular; size small; color very variable, often very boldly mottled. . . . *Eleutherodactylus abbotti audanti.* Size to 27 mm. (USNM 117210).
   No dorsolateral folds 10
10. Dorsum light, uniform, sometimes a white band between the eyes; rear and front of thighs prominently spotted, blotched or reticulated with dark brown on a whitish (yellow in life) ground color; belly granular; disks large. . . . *Eleutherodactylus varians wetmorei.* Size to 40 mm. (MCZ 31733).
    Not as described 11

1 Measurement from a Port-au-Prince specimen. Other measurements are from Cochran (1941) unless otherwise indicated by a reference or a museum number.

11. A broad dark middorsal band, spotted or mottled with darker (especially at its lateral edges), extending from head part way at least onto body and bounded laterally by whitish dorsolateral streaks; limbs unpatterned or only weakly spotted; digital dilations large, that of third finger nearly equal to tympanum 12
    Pattern not as described, or if pattern somewhat similar, digital dilations small 13
12. Vomerine teeth not extending beyond outer edge of choanae; frequently a narrow light middorsal line present; flanks never mottled. . . . *Eleutherodactylus bakeri heminota* new subspecies. Size to 30 mm. (MCZ 31735).
    Vomerine teeth extending well beyond outer border of choanae; never a narrow light middorsal line; flanks sometimes mottled. . . . *Eleutherodactylus armstrongi.* Size to 43 mm. (MCZ 34366).
13. Vomerine teeth short, not extending beyond outer borders of choanae; swollen discolored glandular areas present over forelimb, in front of thighs and on posterior edge of thigh near knee (sometimes difficult to see) 14
    Vomerine teeth long, extending beyond outer borders of choanae; no glandular areas 16
14. Digital dilations feeble; ground color light with a broad darker middorsal band extending from head part way down body but with no dorsolateral border of light streaks; size small, to 16 mm in the three known specimens. . . . *Eleutherodactylus glanduliferoides.*
    Digital dilations medium to large; ground color above dark; size larger, to 41 mm 15
15. Digital dilations large, that of third finger about as large as tympanum; dark coloration above and below rather uniform; size to 41 mm. . . . *Eleutherodactylus darlingtoni.*
    Digital dilations moderate, that of third finger smaller than tympanum; coloration above and below often with darker markings; size to 37 mm. (Yale paratype) . . . *Eleutherodactylus leoncei* new species.
16. Digital dilatations feeble; build stocky; much brown and white marking on ventral surfaces, the white mostly concentrated on the belly. . . . *Eleutherodactylus jugans.* Size to 33 mm.
    Digital dilations easily recognized as enlarged; build not stocky 17
17. Lower lip bordered with large dark brown or black spots; underside of lower jaw and chest similarly spotted; back only very obscurely, if at all, mottled or spotted, usually with two whitish short dorsolateral streaks. . . . *Eleutherodactylus furcyensis* new species. Size to 37 mm. (MCZ 31585).
    Lower lip, underside of lower jaw and chest not boldly spotted; back boldly mottled, usually with two long dorsolateral streaks. . . . *Eleutherodactylus pictissimus.* Size to 41 mm. (MCZ 33293).

BUFONIDAE

Bufo güntheri, the single native toad occurring in Hispaniola, is (or was until recently) present in the Port-au-Prince region.

In striking contrast to Hispaniola, six full species of native toads are now recorded for Cuba (Ruibal 1959, Schwartz 1959). None are known in Jamaica, and there is only one rare or nearly extinct species (*B. lemur*) in Puerto Rico and the Virgin Islands. The special factors that have permitted a small radiation of toads in Cuba and have restricted this genus on the other Antilles are not currently understood (but see below, p. 307).

Bufo güntheri was regarded by Ruibal (1959) as related to *Bufo empusus, B. peltocephalus* and *B. gundlachi* on Cuba and to *B. lemur* on Puerto Rico. Cuban *Bufo catalaciceps* and *Bufo taladai* have since been added as members of this group by Schwartz (1959, 1960). Cuban *Bufo longinasus* did not seem closely related and might represent a separate stock. If this analysis is correct only two stocks belonging to the genus *Bufo* have, without human aid, entered the Greater Antilles and only one of these is known to have invaded Hispaniola.

Bufo güntheri Cochran 1941

Bufo güntheri Cochran 1941, Bull. U. S. Nat. Mus. No. 177, p. 8. Type locality: Port-au-Prince, Haiti.

New records. **Eaux Gaillées = D'leau Gaillée:** MCZ 26763-4, 30732-3, A. Curtiss coll. 1950. **Trou Caiman:** USNM 117142-4, 123825-8, A. Curtiss coll. **Hatte Latham:** USNM 123989, A. Curtiss coll.

Recognition marks: a toad of moderate to large size, parotoids circular rather than elongate, warts concentrated on anterior part of back.

Discussion. None of these toads was obtained in the Port-au-Prince area in the most recent collections, though Anthony Curtiss obtained the species in the Cul de Sac in 1950. *Bufo marinus* is now common and may have displaced this native species in its type locality.

Previous records from the Port-au-Prince area are: Port-au-Prince, Diquini, Manneville, Momance. This species may range throughout the island, but the evidence at the moment does not demonstrate this. No specimens have been taken in the eastern part of the Dominican Republic or the southwest peninsula of Haiti. It is known from northern Haiti and the western parts of the Dominican Republic including Barahona (specimens in the Hassler collection).

Bufo marinus (Linnaeus)

Rana marina Linnaeus 1758, Syst. Nat., ed. 10, 1, p. 211. Type locality: America.

Bufo marinus: Cochran, 1941, p. 13.

New records. **Port-au-Prince:** MCZ 33048-65, Luc Whiteman coll., early August, 1959. **Carrefour:** MCZ 33066-7, Luc Whiteman coll., early August, 1959. **Eaux Gaillées = D'leau-Gaillée:** YPM 644, 646, 645, UF 12229, 12230(3), P. S. Humphrey coll., April 16-17, 1959. **Hatte Latham:** USNM 123990, A. Curtiss coll.

Recognition marks: a toad reaching very large size, parotoids enormous, elongate, warts not concentrated on anterior part of back.

Discussion. These appear to be the first records from the Port-au-Prince region including the Cul de Sac Plain. *B. marinus* is said to have been introduced into Haiti by a Dr. Freeman (hence called locally "Freeman").[1] The parent stock is unknown and though *B. marinus* of current usage will undoubtedly be partitioned, it seems best for the present to use this wastebasket name for the Hispaniolan animals.

HYLIDAE

Three of the four Hispaniolan species of *Hyla* are definitely known from the Port-au-Prince region. The fourth may be confidently expected.

An apparent radiation of *Hyla* (four species) on Hispaniola contrasts with the presence of a single *Hyla* species on the larger island of Cuba, while the presence of five native species of *Bufo* on Cuba contrasts with one on Hispaniola. These two genera (and *Leptodactylus* in eastern Hispaniola) are the only frogs in Cuba or Hispaniola breeding in open water and possessing a free-living tadpole stage; it is possible, therefore, that competition for breeding sites or competition of larvae may be a factor in the strange complementarity of species number in *Hyla* and *Bufo* on the two islands, i.e. there may be only a limited number of available breeding or larval niches that have been filled on Cuba mostly by *Bufo* and on Hispaniola mostly by *Hyla*. Whether this be the answer it is our feeling that the complementarity of *Bufo* and *Hyla* in the Greater Antilles should be recognized as a problem for which a solution should be sought.

1 Another story is given by Anthony Curtiss in a letter of September 8, 1944. He states that *Bufo marinus* was introduced into the Port-au-Prince region twelve years before by M. Audant.

There is one feature that may be of importance in this regard. Noble (1923, 1925, 1927) has shown that the Hispaniolan *Hyla* have radiated not only in adult structure but also in breeding site and tadpole structure. Noble's best summary of the situation is in his 1927 paper (p. 95): "In Santo Domingo I found that the tadpoles living in a certain stream called Lo Bracita were all segregated in particular parts of the stream according to their ability to withstand the current. *Hyla dominicensis* laid its eggs in stagnant pools of rain water in the forest or along the stream bank. The tadpoles were round bodied and had the same number of rows of teeth found in some pond species in the North. *Hyla vasta* laid its eggs in little basins in the gravel and stones on the edge of the pools in the mountain torrent (one observation). Six days after hatching the larvae made their way out of the basins over wet stones into the torrent pool. As they grew older, they developed better stream lines than the tadpoles of *H. dominicensis*. They were equipped with more rows of teeth. The mouth was larger and better adapted to holding on to rocks in the stream. The tail was thicker and more muscular than that of the stagnant pool tadpole. Finally *Hyla heilprini* lived at much higher elevations along the stream at places where the water fell in cascades over innumerable rocks. These tadpoles had the largest mouths, the greatest number of tooth rows, the thickest tails and the best stream lines of all. They lived in the swiftest current and were adapted to working their way slowly over the rocks while holding on by their mouths."

Thus at least two of the four Hispaniolan *Hyla* are specialized for a mountain brook habitat.

A radiation of *Hyla* comparable to that on Hispaniola occurs also on Jamaica. However, all four Jamaican hylas breed in bromeliads, *not in standing water*. No native Jamaican frog breeds in standing water, although the introduced *Bufo marinus*, which does so breed, is now established there. It seems probable to us that in this island, and to a lesser extent on the larger islands, the open water breeding site so necessary for most frog genera has at times been unavailable or of an unstable or special character. This might well account for the distributional peculiarities of the genera breeding in open water and, as well, for the impressive success and radiation on these islands of the

leptodactylid genus *Eleutherodactylus,* which omits the free-living tadpole stage.[1]

We have spoken, in both the Jamaican and Hispaniolan cases, of a radiation. Dunn (1926) has presented the arguments for believing in independent radiation on the two islands. The peculiar breeding site and the correlated specialized tadpole characteristic of all the Jamaican hylas do indeed speak strongly for such a Jamaican radiation, and, if this be admitted, the Hispaniolan radiation becomes more plausible.

The situation is a very singular one. On Jamaica and Hispaniola (and on Cuba) there is a middle-sized *Hyla* with the skin of the head adherent to the skull. The close relationship of these three helmeted hylas (*H. brunnae,* Jamaica, *H. septentrionalis,* Cuba, *H. dominicensis,* Hispaniola) to one another is admitted by everyone; it has even been postulated that they form a single species. The breeding and tadpole peculiarities of *Hyla brunnea* seem sufficient to require that at least the Jamaican form be considered a distinct species (cf. Myers, 1950).

On Jamaica and Hispaniola there is in each case one giant *Hyla.* In this instance the Jamaican and Hispaniolan species are clearly distinct. The Jamaican form, *H. lichenata,* is again a casque-headed species; the Hispaniolan form, *H. vasta,* is not. *H. vasta* has dermal fringes along its fore and hind limbs like certain Central American species; *H. lichenata* does not.

Jamaica and Hispaniola, in addition, each have two smaller species of *Hyla. H. heilprini* of Hispaniola is not particularly small, not casque-headed, and has a strong prepollex. It is quite unlike any Jamaican form and not very similar to any of its congeners on Hispaniola. *Hyla pulchrilineata* of Hispaniola and

[1]The singularity of the Jamaican situation is underlined by the presence in this island of a group of carabids uniquely restricted to bromeliads — the *bropactiarum* group of the genus *Colpodes.* Just as none of the other islands have bromeliad breeding hylas, so none of the other islands have bromeliad restricted carabids. Darlington (1953, Occ. Pap. Inst. Jamaica No. 8, p. 2) describes the situation as follows: "The mountain *Colpodes* of Cuba, Hispaniola, and Puerto Rico include many endemic species, but there are obvious or apparent relationships among the various ones on different islands. The *Colpodes* of Jamaica (excepting the widely distributed, winged, riparian *C. aequinoctialis* (Chd.)) form several groups so distinct that their relationships can hardly be guessed at, and they, more often than the *Colpodes* of the other islands, have tended to lose tactile setae and to radiate ecologically — none of the other islands has anything like the Jamaican *bromeliarum* group of the genus, confined to epiphytes. This contrast between a relatively non-endemic lowland fauna and a strikingly endemic mountain one is well accounted for if Jamaica is an old island, which has always been more isolated from the other islands of the West Indies than the latter have been from each other, and if the lowlands have been recently sunk under the sea or have only recently emerged from it, so that the lowland carabid fauna is composed mostly of recent emigrants, while the mountain fauna is composed mostly of old and isolated endemics. This suggests obvious things about the history of Jamaica which are worth the consideration of geologists as well as of zoogeographers."

H. marianae and *H. wilderi* of Jamaica are less distinctive forms, but again there is little ground for comparison between the Jamaican and Hispaniolan species.

Thus, even if Dunn's hypothesis of separate radiations on the two islands is rejected, we do not have, except for the *brunnea-septentrionalis-dominicensis* triad, any clear case of inter-island relationship. If we reject Dunn's hypothesis we may be compelled to postulate as many as seven independent incursions of *Hyla* into the Greater Antilles, only one of which reached more than one island. Remarkable as Dunn's suggestion is, and despite the convergence it implies in the case of *Hyla vasta* and *Hyla heilprini* with certain mainland stocks, it seems very definitely the simplest available hypothesis.

Hyla heilprini Noble

Hyla heilprini Noble, 1923, Amer. Mus. Novitates, no. 61, p. 1. Type locality: Lo Bracita, Pacificador Province, Dominican Republic = Los Bracitos, Duarte Province.

Hyla heilprini: Cochran, 1941, p. 22.

New records. **Furcy:** MCZ 26784, 29688, A. Curtiss coll.; MCZ 31715-6, E. E. Williams and A. S. Rand. coll., August 9, 1959; MCZ 33676, Luc Whiteman coll., May, 1960; MCZ 34181-2, Luc Whiteman coll., March, 1961; AMNH 55140, USNM 118034, 120971-4, 123368, 123794, A. Curtiss coll.

Recognition marks: a tree toad of moderate size appearing to have 5 fingers, i. e., a strong prepollex present, fingers extensively webbed, color in life with bright greens and yellows, in preservation uniform brown or with small white spots.

Discussion. There appears to be no difference between Furcy examples and those from the Dominican Republic. A specimen recently obtained by the MCZ from the vicinity of Jeremie seems also quite typical. This is thus an island-wide form showing no evident differentiation.

Though preserved specimens are an almost uniform, unimpressive, light brown, perhaps with some white spots or traces of banding, the living animal is very strikingly colored, even gaudy. We have notes on color in life for certain MCZ specimens.

MCZ 31715: Grass green above. A yellow line along posterior edge of arms and of tarsi. Orange above eye continuing on canthals to nostril. Thighs posteriorly narrowly crossbanded in black on a grey ground. Digital pads bluish. Below: lower lips green. Throat white marked with pale yellow. Center of belly

and of underside of thighs orange. Blue tints on underside of arms, along sides of belly, across chest. Strong blue color in groin and on anterior edge of thighs and on tibiae. Digital pads blue, palms marked with orange. Orbit yellow.

MCZ 31716: Same but orbit dark blue. No orange above or on canthus. Lower flanks with distinct mottling and spotting.

Descriptions by Anthony Curtiss of color in life of Furcy specimens follow. Letter of August 30, 1943, to Doris Cochran: "Upper parts green, eyes pale golden with black pupils. Underside sky blue but tinged with pale orange on middle of abdomen and under the thighs."

Letter of December 22, 1944: "Green above, even in life with faint dusky bars across the back (interesting because not usually found in my specimens from Furcy). Hind thighs with similar more vivid bars. Irides golden yellow with sky blue margins and black pupils. Disks of toes greenish blue. Body below orange yellow, throat white."

Noble (1923) describes Dominican *heilprini* as a similarly showy animal: ". . . a brilliant golden green frog flecked with white above and partly concealing with his legs four gaudy patches of the brightest gold."

Noble in the same paper has described the voice of this species vividly. It is ". . . a shrill cry . . . like a jet of escaping steam or a locomotive whistle stammering under excess pressure."

It is to Noble also that we owe a figure of the tadpole of this species (1927, pl. IX, fig. C), and the knowledge of its special adaptations to the swifter areas of mountain streams. He describes the color of the tadpole as mottled gray and yellow, with the yellow marks on tail and rump forming a distinctive pattern.

Hyla vasta Cope

Hyla vasta Cope, 1871, Proc. Acad. Nat. Sci. Philadelphia, p. 219. Type locality: "Near the city of Santo Domingo, W. I."

Hyla vasta: Cochran, 1941, p. 19.

New records. **Furcy:** MCZ 26785-90, A. Curtiss coll., 1950; MCZ 31717-27, YPM 1642, E. E. Williams and A. S. Rand coll. August 8-9, 1959; MCZ 33675, Luc Whiteman coll., May, 1960; MCZ 34183-202 (+ 2 dupl.), Luc Whiteman coll., March, 1961; USNM 117112-3, 118837-8, 123367, A. Curtiss coll. **Mt. Bourette, Furcy:** MCZ 24281-3, E. Folk coll. 1940.

Recognition marks: a very large tree toad with extensively webbed fingers and a scalloped fringe or ridge on the edges of

the limbs, warts conspicuous on the hind limbs, color mottled gray without distinct pattern.

Discussion. Not recorded from the Port-au-Prince area at the time of Miss Cochran's 1941 summary, it is now abundantly documented and seems a moderately common species in the Furcy area. Specimens already in museums (from Camp Perrin above Aux Cayes on the southwest peninsula and from various localities in the Dominican Republic) had indicated the island-wide breadth of its range.

The color in life, as Noble (1923) and Mertens (1939) have commented, is remarkably like that of lichen-covered trees.

All of Anthony Curtiss' specimens came from the first two valleys south of Furcy where two streams join in front of Morne Bourette. The region is called "Sourgailles." Since this is part of the general Furcy area, they have been so catalogued and are so cited above.

A letter from Anthony Curtiss to Doris Cochran, May 31st, 1944, contains the following notes:

"During dry spells, as Dr. Noble says, this frog remains hidden during the day, high up in the tops of the trees, descending at night to the mountain streams to do its courting, but once the rains set in in earnest the giant tree frog may be found late in the afternoon during the drizzling mist on branches fairly low down, not far from streams.

"You may have noticed that in one of Dr. Noble's articles [1923] he tells us that the excreted venom of *Hyla vasta* burns the hands. I have handled over a dozen living examples of this giant tree frog, but I have never been burnt by them. Perhaps this venom, like that of our poison ivy, affects only certain people. My wife's cousin and several of his comrades have caught and handled frogs of this kind from time to time, bringing them home to me, but none of them were ever burnt or poisoned thereby. . . . The country people say, however, that this frog poisons and nauseates dogs that take it up in their mouth."

Some additional comments may be made on the poisonous skin of Hispaniolan hylas. Curtiss himself elsewhere (letter of August 14, 1944) remarks that "*Hyla* cannot travel with *Eleutherodactylus* [i.e. be carried in the same container with the latter]. . . . *Hyla* sometimes appears to poison *Eleutherodactylus*." Lynn (1958, p. 154) has said of *Hyla dominicensis* that "collecting this hyla was attended by an unexpected hazard in that the glandular secretion proved irritating to any small cuts and

scratches." Thus there is independent evidence from several sources of poisonous secretions from the skin of Hispaniolan hylas. On the other hand, none of the personnel of the recent expeditions (Humphrey, Williams, Rand, Lazell) though handling many hylas, noticed any reaction. There thus seems to be merit in Curtiss' idea of immune and allergic reactions in different individuals.

Noble (1927, Pl. IX, fig. B) has figured the tadpole of this species. He states (1923) that the tadpoles closely resemble the rocks on which they rest in the pools of the lower portions of mountain streams.

Hyla pulchrilineata Cope

Hyla pulchrilineata Cope, 1869, Proc. Amer. Phil. Soc., 11, p. 163. Type locality: Eastern part of San Domingo Id. = Eastern Hispaniola.
Hyla pulchrilineata: Cochran, 1941, p. 17.

Recognition marks: a small tree toad with light longitudinal lines on body and limbs, fingers and toes not extensively webbed, skin of head smooth.

Discussion. Recorded from Mariani, west of Port-au-Prince on the north coast of the southwest peninsula of Haiti, this species was not obtained in the three recent collections in the Port-au-Prince area. The Hassler collection in the American Museum, however, contains specimens from the southwest peninsula in the vicinity of Aux Cayes; the MCZ has recently received other specimens from the same region. Since the species is also known from localities in northern Haiti and in the Dominican Republic, the Port-au-Prince area is neatly bracketed and it is entirely logical to expect it in the environs of the capital. Failure to obtain it in 1959-1960 may probably be charged to the accidents of collecting.

Lynn (1958, p. 154) describes the call of this species in northern Haiti as "a faint clicking."[1] He found it "fairly common" on leaves two to eight feet above the ground on low bushes arched over a spring. Color in life was "back olive green; a middorsal line of light yellow; paired yellow lines beginning at nostrils and extending through eyes to groins; similar lines on upper lips continuing below eyes to groins; yellow lines on dorsal surfaces of all limbs; ventral surfaces white; considerable

1 Noble (1923) writing of this species from the Dominican Republic, described the call as "very penetrating — sounding like the rhythmical creaking of an old harness.

variation in the prominence of the lines; some showing all lines clearly, whereas others exhibited almost none." Rand (field observations, 1960) reports the colors in life of specimens from Dondon and Aux Cayes as brown with yellow lines.

Hyla dominicensis (Tschudi)

Hypsiboas dominicensis Tschudi, 1839, Mem. Soc. Nat. Neuchatel, 2:30. Type locality: Insel St. Dominique = Hispaniola.
Hyla dominicensis: Cochran, 1941, p. 13.

New records. **Port-au-Prince:** MCZ 26751, A. Curtiss coll.; MCZ 31697-707, Luc Whiteman coll., early August, 1959; MCZ 317100-12, E. E. Williams and A. S. Rand coll., August, 1959; MCZ 34165, Luc Whiteman coll., March 1961; USNM 118828-31, A. Curtiss coll. **Damien:** MCZ 31693-6, Luc Whiteman coll., early August, 1959; MCZ 31713, E. E. Williams and A. S. Rand coll., August, 1959. **Diquini:** MCZ 31708-9, E. E. Williams and A. S. Rand coll., August, 1959; USNM 117107-8, A. Curtiss coll. **Cave at Diquini:** USNM 117288, A. Curtiss coll. **Turgeau near Port-au-Prince:** USNM 140220-1, W. A. Lynn coll. **Petionville:** MCZ 31690-2, Luc Whiteman coll., early August, 1959. **Ça-Ira near Leogane:** MCZ 34166-80 (+ 8 dupl.), Luc Whiteman coll., March, 1961. **Eaux Gaillées = D'leau Gaillée:** YPM 1641, P. S. Humphrey coll., April 17, 1959. **Trou Caiman:** USNM 123805-9, 123811-23, A. Curtiss coll. **Hatte Latham:** USNM 118863-4, 123348-9, A. Curtiss coll. **Thorland:** USNM 118836, A. Curtiss coll. **Trou Forban:** USNM 117109, A. Curtiss coll. **Nan Café = En Café,** Gonave Id: MCZ 31950-1, YPM 1623-1639, UF 12221-8(30), P. S. Humphrey coll., March 26, 1959.

Recognition marks: a tree toad of moderate to large size, skin of head finely rugose because of strong adherence to the bones of the skull, fingers not extensively webbed, pattern variable, obscure, but hind limbs with dorsal cross bands.

Discussion. Previously recorded from Port-au-Prince and Diquini, we report here the first specimens from the Cul de Sac Plain and from Gonave Id. The Gonave specimens do not appear to differ from those from the "mainland" of Hispaniola. This, the common *Hyla* of the lowlands, appears not to occur at Furcy. Mertens (1939) reports its occurrence in the Dominican Republic up to 1000 m. (*ca.* 3000 ft.)

As Lynn (1958, p. 153) has reported, there is wide power of color change and no well marked pattern. Usually "specimens taken at night were light gray with a tinge of greenish and

with obscure darker blotches on the back. Some had yellowish blotches in groin and axilla. After capture most turned dark brown with the blotches more prominent and nearly black. In life the bones of the legs showed green through the skin. The iris was light blue except for a gold border around the pupil." His specimens were from Turgeau near Port-au-Prince and from near Limbe in northern Haiti. He did not record, nor do we find any evident geographic differentiation.

Curtiss in a letter of August 18, 1950, mentions that *Hyla dominicensis* appears to have no special reproductive season. In another letter of April 10, 1946, he reports the following: "Yesterday, late in the afternoon in a small hole in a tree, I saw two tree toads. The female blocked the opening with her head, as the largest Jamaican tree toad is said to do, and sheltered beneath her the smaller male. These were *dominicensis,* of course."

Again a figure of the tadpole has been furnished by Noble (1927, Pl. IX, fig. A). This is decidedly less specialized than those of the two species breeding in mountain springs and correspondingly adapts itself to very quiet and often very small bodies of water. Noble (1923) describes the conditions that he saw in the Dominican Republic: "In the mud puddles and ponds of stagnant water there were myriads of fat-bodied pollywogs, iridescent brown in color and with a few short rows of larval teeth."

LEPTODACTYLIDAE

Of the two leptodactylid genera known in Hispaniola, *Leptodactylus* is not yet recorded from the Port-au-Prince region. *Eleutherodactylus*, on the contrary, is abundantly present, abundant both in numbers of species and in numbers of individuals.

The number of species of *Eleutherodactylus* in this area, as in the Greater Antilles in general, poses both strictly taxonomic and wider biological problems:

1. The behavioral and ecological differences which must exist between such a number of species from one area are quite unanalyzed. The large disks of certain species (e. g. *varians wetmorei* and *bakeri heminota*) presumably imply that these are arboreal, just as the reduced disks of others (e.g. *jugans* and *glanduliferoides*) imply life on the ground.

2. At the lowest taxonomic level discrimination is difficult. Quite valid species differ in very subtle ways and may be distin-

guishable most readily by colors in life or by voice. We have cited colors in life wherever possible, but we have little information on voice and it is probable that some species are not vocal.

3. Even more difficult than species discrimination (at least on the characters currently employed) is recognition of species groups. Dunn (1926) and most recently Schwartz (1958) have endeavored to define and establish species groups for Cuba and Jamaica in the laudable effort to bring order into an otherwise extraordinarily confusing assemblage. Following them, we have similarly endeavored to place our Hispaniolan species and it is evident enough that the species groups established, e.g. for Cuba, do seem useful also on the other islands. However, as will be very clear from the discussions which follow, the content and boundaries of species groups are uncertain and difficult; there appear

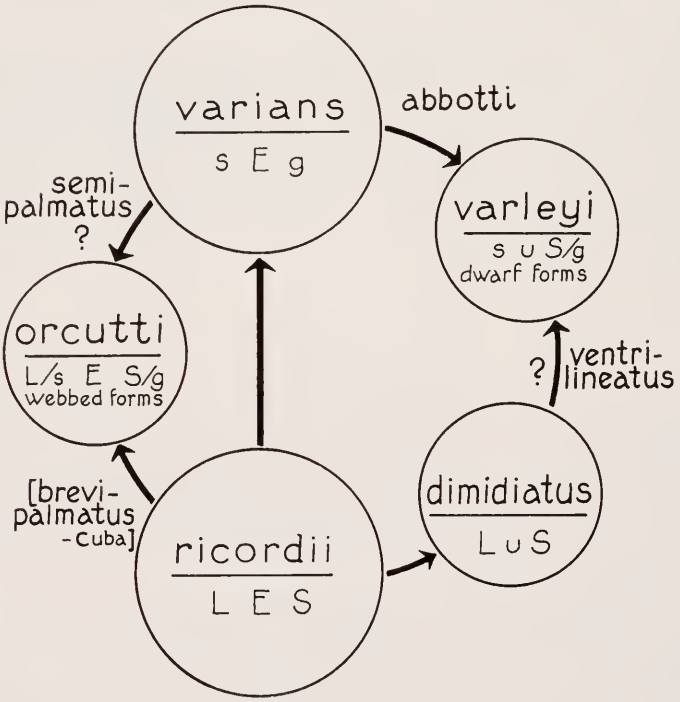

Fig. 2. Diagram to show the characters and possible relationships of the groups of Hispaniolan *Eleutherodactylus*. L = long vomerine series, s = short vomerine series, E = enlarged digital disks, u = digital disks small or undeveloped, S = smooth belly, g = granular belly.

TABLE 2

Characters of the species groups of *Eleutherodactylus* in the Port-au-Prince region.

Groups	*Vomerine Series*	*Digits*	*Size*	*Belly*	*Webbing*	*Glands*
varians	short [1]	greatly enlarged	very large to very small	granular	—	—
orcutti	short or long	greatly enlarged	moderate	granular or smooth	+ variable in amount	—
ricordii	long	greatly to moderately enlarged	moderate	smooth	—	+ —
dimidiatus	long	undeveloped	moderate	smooth	—	—
varleyi	short	undeveloped	small	smooth or granular	—	+ —

audanti — annectant *varleyi-varians*
ventrilineatus — annectant *varleyi-dimidiatus*
brevipalmatus — annectant *orcutti-ricordii*
semipalmatus — annectant *orcutti-varians*

1 short = *not* extending beyond outer borders of choanae ; long = extending beyond outer borders of choanae.

to be annectant or ambiguous forms. We therefore grouped our species hesitantly and tentatively and with the consciousness that we have not examined enough material or used enough characters to be quite successful in the attempt. We have gone ahead in spite of our hesitations in the hope that even a reckless suggestion may be more useful than too careful a silence.

To better illuminate the problems raised we have tabulated the characters of our groups (essentially the same characters used by Dunn and Schwartz), and have listed also the annectant forms we have observed. It is obvious enough that such annectant forms may be real phyletic links or mere convergences; we lack, however, the evidence on which to choose between these alternatives. In Figure 2 we show in a dendrogram possible relationships between our groups, assuming the *ricordii* group to be primitive relative to the other Greater Antillean *Eleutherodactylus*. Where annectant forms exist, we have placed their names alongside the arrow showing the possible derivation of a group. As we have treated the evidence, it would appear that the smaller groups (*orcutti, varleyi*) are polyphyletic, but the situation may be more complex than this; the larger groups may themselves be composites. We very obviously need new characters to add to the few now used.

The varians group

Schwartz (1960) has shown that *auriculatus* Cope is the prior name for *sonans* Dunn and that *auriculatus* auct. is conspecific with *varians* Dunn. We therefore prefer *varians* as a group name for the species complex formerly called the *auriculatus* group and characterized by the short vomerine series, the greatly enlarged disks and the granular belly. We include here very large forms (*inoptatus*), very small forms (*audanti*), and forms of medium size. This is a very diversified assemblage and perhaps polyphyletic.

Eleutherodactylus inoptatus (Barbour)

Leptodactylus inoptatus Barbour, 1914, Mem. Mus. Comp. Zool., 44: 252. Type locality: Diquini, Haiti.

Eleutherodactylus inoptatus: Cochran, 1941, p. 27.

New records. **Furcy:** MCZ 26779-83, A. Curtiss coll.; MCZ 31811-9, E. E. Williams and A. S. Rand coll., 1959; MCZ 33660-74, YPM 648-662, Luc Whiteman coll., May, 1960; MCZ 34203-6,

(+1 dupl.); AMNH 55137-9, USNM 118033, 118839-42, 120979-97, 123369, A. Curtiss coll. The numbers listed above include many eggs and young.

Recognition marks: a large frog with a more or less conspicuous fleshy pustule or spine on the anterior part of each eyelid, dorsolateral folds present, disks of toes only moderately enlarged.

Discussion. A very widespread form occurring both at high and low altitudes. Not previously recorded from Furcy (5000 ft.), the type is from nearby, but lowland, Diquini. Several specimens were taken with eggs, the adult guarding each clutch, in small pools as described by Noble (1923).

Lynn (1958, p. 154) has described specimens from Limbe in northern Haiti: "back light brown with blotches of darker brown between eyes and irregularly distributed on back; dark brown bars on lower arm and upper and lower leg; sides below glandular ridge slate with small spots of black; black line through eye extending over and behind tympanum; loreal region light tan; groin and undersurfaces of hind limbs light yellow; belly white; throat with suffusions of brown; iris brown with a dark horizontal line through the center."

Mertens (1939), in contrast to Noble, describes this form as a ground dweller, the color of which is very like that of a forest floor covered with fallen leaves. Noble thought it a climber on vine-covered trees.

Anthony Curtiss has extensive notes on this species:

Letter of April 2, 1943: "Quacks like a bull frog when handled. . . . In life the underparts were buffy whitish forward, purplish white to the rear, the back blackish."

May 23, 1943 [of an adult taken with an egg mass of two dozen or so globular eggs]: "She was found in a burrow on a mountain slope with grass hanging down and half hiding the entrance. This was beyond Morne Bourette on the road to Cabaio."

August 30, 1943: "The female (sometimes with one or two smaller attendants — ? males) in May, June, July and August may be found in burrows near springs at Furey, Morne La Visite, etc. She utters in the evening a strange continued croak — or is it her attendants?"

November 2, 1943: "In life (if they are all one species) some are pea green on the back with the sides dark (blackish with a green tinge); others have the back spotless "cafe-au-lait" and the sides blackish; others have the upper parts (back and sides)

pale greenish black; others have the back and sides pale olive. The tubercle over the eye may be large or almost obsolete and the interorbital bar may or may not be present.

"The present specimen has the tubercle larger and the upper parts rougher than any seen by me. About two dozen round eggs were with her. In life her sides were brown, the upper third golden and her pupils were black. Her eardrums were golden with a black spot on the hinder part. Her body above was variegated with brown with a lengthwise yellow line on each side of the back . . .; the hind legs were banded crosswise with green and brown on their upper side. The underparts were pale, the throat being pale green variegated with brown and the abdomen and hind legs (on the underside) pale orange with brown spots. The underlip had short vertical white stripes on it, two of these being continued up to just under the eye."

July, 1944: "*Inoptatus* was brooding everywhere, usually on hillsides near springs. The brooding mother frogs croak towards sundown (earlier on cloudy days) and captive brooders in their jars will croak if sprinkled with water. The barking or yelping I have only observed two or three times in the dozens of times I have handled *inoptati*.

". . . A mother *inoptatus* that had hatched one set of eggs was given some other eggs of that species of which the parent had not been captured. She took charge of them and hatched them. The baby frogs remain under, around and on the mother for several days after hatching. The mother is weak and lean after incubation."

Eleutherodactylus abbotti audanti Cochran

Eleutherodactylus audanti Cochran, 1934, Occ. Papers Boston Soc. Nat. Hist., 8:164. Type locality: Peak La Selle, Haiti.

Eleutherodactylus audanti: Cochran, 1941, p. 65.

New records. **Mt. Cabaio** (7000 ft.): MCZ 24280 + (4 dupl.), USNM 109172, G. E. Folk, Jr. coll., 1940. **Bois Pin near Marigot:** MCZ 24586-8, Walter Paine coll., 1941. **Forêt des Pins:** MCZ 31953-63, YPM 1202-1241, UF 12231-41(60), P. S. Humphrey coll., March, 1959. **Morne La Visite:** USNM 11703, 117118-20, 117123-6, 117128-32, 118858, A. Curtiss coll. **Furcy:** MCZ 31797, E. E. Williams and A. S. Rand coll., August, 1959; MCZ 33546-87, YPM 682-702, Luc Whiteman coll. May, 1960; MCZ 34207-306 (+71 dupl.), Luc Whiteman coll., March, 1961; AMNH 55093-94, 55142-3 (+ 11 dupl.), 55144; USNM 117114,

118852-5, 120998-9, 121002-5, 121011, 121014-5, 121026-30, 121032-9, 121488-92, 121497-505, 121563-6, 123371-5, A. Curtiss coll.; INHS 9492-502, M. Sanderson coll.

Recognition marks: a small frog with short dorsolateral folds and a granular belly; vomerine series very short, widely separated, their outer margin not extending as far as the inner borders of the choanae; disks of toes only moderately enlarged, hind limbs short; coloration very variable. Males with a conspicuous vocal sac.

Discussion. As Cochran mentioned in the type description of *audanti,* there is extreme variation in color in the specimens referred to this form. Some specimens are almost entirely yellow, others nearly black. Various irregular mottled conditions may be present. More regular patterns also occur, e.g. a narrow white vertebral line connecting with lines on the rear of the thighs and (often with the pattern just mentioned) light dorsolateral lines. We have considered the possibility that we are here confusing two or more taxa. There seems, however, to be no correlation of structural and color differences.

We have above reduced *audanti* Cochran 1934 to a subspecies of *abbotti* Cochran 1923. We do this because of the presence in the lowlands of the Port-au-Prince region and on the southwest peninsula and in Barahona of equivocal specimens which appear to be in various grades and degrees intermediate between *audanti* and *abbotti.* Even certain Furcy specimens seem to show intermediacy, and only the highest elevations (Forêt des Pins, Morne La Selle) seem to be unqualified *audanti.*

The differences between these two taxa (and *minutus,* discussed below) are listed in Table 3.

As the table indicates, we have found no absolute differences between these forms, indeed none that are easily made objective. It follows that while populations are reasonably distinct (especially with comparative material), single specimens are at times difficult. Thus a specimen of *abbotti* from Sabana de la Mar in the lowlands, far from any possible area of intergradation, is more spotted, more like *audanti,* than typical *abbotti.* This situation coupled with the small apparent range of pure *audanti* and wide zone of "intergradation" could very legitimately raise the question of even subspecific separation. We have at this time preferred a less radical alteration of existing nomenclature.

A short summary of our interpretation of the *abbotti* complex is in order.

E. abbotti Cochran is the form characteristic of Hispaniola north of the Cul de Sac. It is rather uniform in morphology and coloration and at least present collections would suggest that it is nowhere very abundant. It was described from Laguna on the Samana Peninsula in the Dominican Republic, a lowland locality, but it is known also at *ca.* 3000 feet at Constanza, Mt. Diego de Ocampo, and from Loma Rucilla at 4000-7000 ft., and from Loma Vieja at 6000 ft. In Haiti it is known from the Citadelle and Grande Riviere (MCZ 3100, 3520, W. M. Mann coll., not listed by Cochran).

The highland localities for *abbotti* in the Dominican Republic pose a special problem, that of the relationship of *abbotti* Cochran to *minutus* Noble 1923 and *haetianus* Barbour 1942 (= *intermedius* Cochran 1941 preoccupied). These forms are recorded from localities higher (8000-10,000 feet) than or (as reported) overlapping with the highland localities for *abbotti*. We regard *haetianus* as a synonym of *minutus,* which again we are inclined to interpret (on the evidence of intergrading populations at *ca.* 7000 feet) as a highland race of *abbotti*. The problem is complex and it is not appropriate to discuss it here.

Audanti was described from the highest peak of the La Selle range (Morne La Selle). It is now abundantly documented (but somewhat compromised) at the intermediate level of Furcy (*ca.* 5000 ft.). At these heights the majority of specimens, though similar to *abbotti*, are clearly different in both morphology and coloration. Nothing, for example, comparable to the orange or asymmetrically pigmented specimens of *audanti* occurs in the *abbotti* populations north of the Cul de Sac. However, at Furcy, certain specimens are puzzling and might be referred to *abbotti* were they not connected by insensible gradations with the extreme conditions to which the name *audanti* applies.

In these higher altitudes *audanti* is a very abundant frog. The similar frogs in the lowlands or even at altitudes 1000-2000 feet south of the Cul de Sac Plain are much rarer. In the unreported collections of the American Museum there are a number of individuals from the Barahona Peninsula belonging to this complex. There is a specimen (MCZ 33280) from Morne Decayette, a hill from *ca.* 1000 ft. elevation quite near Port-au-Prince, and also a specimen from Petionville (USNM 59111). There is also a National Museum specimen (USNM 72661) from Fond des Negres (again poorly preserved) and doubtfully referred to *abbotti*. A specimen has recently come to light from

Thiotte near Sal Trou. None of these specimens is unambiguously referable to either *abbotti* or *audanti;* instead there is an erratic recombination of *audanti* and *abbotti* characters. We interpret these lowland specimens as true intergrades, the Furcy material as essentially *audanti* but as showing traces of gene flow from *abbotti* and only the frogs of the La Selle peaks as uncontaminated *audanti.*

A curious phenomenon which we do not here attempt to explain is the presence in the foothills of the La Hotte range (American Museum material) of frogs much more like *abbotti* than any others in the area south of the Cul de Sac Plain. There is also indication of a *minutus*-like form at higher elevations in the Massif de La Hotte. The available specimens from this area are, however, few and poorly preserved; a better sample will be necessary before any discussion is possible.

TABLE 3

	abbotti	*audanti*	*minutus*
loreal region	steep	sloping	sloping
snout	longer	short	very short
ventral granulation	less coarse	less coarse	coarsely granular
digital dilations	enlarged	enlarged	scarcely enlarged
length of hind limb	to eye moderate,	short of eye moderate,	short of eye heavy, only
vomerine teeth	oblique	oblique	slightly oblique
color	lighter, more uniform	usually darker, often heavily marked	darker, more uniform

Humphrey and Van Vleck, collecting in the dry season, found *audanti* with *E. leoncei* n. sp. (see below) under trunks of fallen trees in the Forêt des Pins and under large fallen branches at Marie Claire in an area of pine forest that had been burned several years before, and in and around moist decaying wood under large logs among otherwise dry ground litter at several other areas in the Forêt des Pins. Anthony Curtiss' observations are similar (letter of April 7, 1943) ". . . [*E. audanti*] is found under stones, under fallen logs, in crevices in roadside banks, and at rainy times (and it rains a good deal up there) among the foliage of not too lofty plants." Curtiss thought he knew the voice of this animal: ". . . the piping of this tiny frog is like the ringing of some baby spook's bell in the evenings or on rainy afternoons."

Eleutherodactylus varians wetmorei Cochran.

Eleutherodactylus montanus Cochran, 1924, Proc. U. S. Nat. Mus., 66, art. 6: 2. Type locality: Fond des Negres, Haiti (*nec montanus* Schmidt, 1919).

Eleutherodactylus wetmorei Cochran, 1932, Proc. Biol. Soc. Washington, 45:191.

Eleutherodactylus auriculatus wetmorei: Cochran, 1941, p. 74.

Eleutherodactylus varians wetmorei: Schwartz, 1960, Reading Public Mus. and Art Gallery Sci. Publ., no. 11, p. 6.

New records. **Boutillier Road:** MCZ 31733, E. E. Williams and A. S. Rand coll., August 9, 1959.

Recognition marks: a frog of moderate size, disks of fingers large, of toes moderate, head sometimes with a white blotch between the eyes, dorsum unpatterned, rear and front of thighs very prominently blotched with dark on a light ground color; this ground color is yellow or orange in life.

Discussion. This lowland form has until recently been represented by only a few specimens. The type series from Fond des Negres on the southwest peninsula of Haiti consisted of only four individuals. Eleven more from Moron, Haiti, were referred to the species by Cochran in 1941. The American Museum has specimens (AMNH 44050-1) from Columbia on the south side of the La Selle Range and from La Mahot near Columbia (AMNH 44035-7), all collected by Hassler. The MCZ jointly with Carnegie Museum has obtained two from Marbial, 21 km. NE of Jacmel and very recently a large series (34 specimens) was obtained near Sal Trou. The Boutillier specimen, the first from the Port-au-Prince area, has no white on the head (no interocular band), but this is true of some of the type series. There also appears to be somewhat less black in the limb and groin markings (but the Moron series, two now in MCZ, have no markings at all). Length of head and body 40 mm.

We follow Schwartz (1960, p. 5) in referring *wetmorei* Cochran to the species *varians* as newly interpreted by him. *E. auriculatoides* Noble from the central Dominican Republic, which is probably conspecific with *montanus* Schmidt, is considered by Schwartz specifically distinct from *wetmorei.*

We have unfortunately no descriptions of color in life, but freshly preserved specimens (Sal Trou region) show the following: General dorsal hue gray brown. Interocular light band present or absent. Hinder edge of thigh and, less consistently, anterior edge of thigh and groin bright orange with black flecks. Edges of orange areas may or may not be bounded by a

narrow black line or series of black spots. Orange with black flecks sometimes on ventral surface of tibiae. Underside of body, head and thighs grayish, sometimes finely powdered with black, especially on the chest.

Eleutherodactylus bakeri heminota[1] subsp. nov.

Type. Museum of Comparative Zoology 31734, a gravid female, from **Furcy, Republic of Haiti,** collected by E. E. Williams and A. S. Rand, August 8, 1959.

Paratypes. MCZ 31735-96, 31798-810, YPM 704-760, with the same data as the type; MCZ 34379-478 (+ 71 dupl.), CM 37781-5, Luc Whiteman coll., March, 1961; AMNH 55089-90, 55092, 55144, USNM 121006-10, 121019-20, 121495-6, 123376, 123795, 123798-9 collected by Anthony Curtiss, all from **Furcy.**

Diagnosis. This form differs from typical *bakeri* in color and in apparently smaller size.

Recognition marks: a frog of small size with large digital disks. General ground color of body light; on back a broad dark band extending halfway to vent and bordered laterally by whitish, flanks not mottled. *Vomerine teeth short, not extending beyond outer margins of choanae.*

Coloration. Above, yellowish gray or light gray; a fine white vertebral line; beginning at about the level of the eyelids, and joining them, a broad dorsal longitudinal band, grayish in color, and becoming obsolete about half way down the body; the band heavily dotted, spotted, and bounded with irregular, coarse, black markings; on either side of the dorsal band, narrow light, rather obscure, streaks made by a lightening of the ground color, the ground color sprinkled or finely dotted with brown or black, the grayish color of the band resulting from an intensification of this; a black line beginning near the end of the snout going through the eye and ending in the fold over the tympanum. Below, ground color the same as that above, and also dusted with dark brown or black. In the paratypes the dorsal markings occur in various degrees of distinctness. Sometimes the ground coloring of the dorsal streak is not visible, and the streak is outlined only by the black spots mentioned above. Even these may be obsolete, or nearly so, and if, coupled with this, the light dorsal streaks are also obsolete, little if any trace of the dorsal band remains; this occurs in a few specimens. In some the band is not well

1 So named because of the dark dorsal band becoming obsolete half way down the back.

defined on the head. The fine light vertebral line is frequently absent or nearly so. Bands on the limbs occur in some.

Three specimens (MCZ 34379-81) which probably belong here show a decided intensification of the dorsal and ventral "sprinkling" (no intensification in one specimen ventrally) mentioned in the description, with the animals being decidedly grayish or blackish, this color becoming more "patchy" posteriorly, showing much of the ground color on the hind limbs and posterior part of the body. The dorsal band is nearly obsolete, although there is slight evidence of the lighter dorsal streaks and of the coarse black markings. The darkening of nearly the whole dorsum is about equal to that of the band in the usual specimen, hence the lack of distinctness.

Typical *bakeri* usually has no dorsal band as described above, but when present (sometimes including lighter streak at side), it never becomes obsolete posteriorly nor has the coarse black spots of *heminota*. In general, in *bakeri,* the back, darker than in *heminota,* is uniformly dotted and vermiculated with darker brown.

Measurements. Type, head and body length, 29 mm. The same for the largest paratype 30 mm. (MCZ 31735). Typical *bakeri* reaches 38 mm.

Remarks. The new form and bakeri are so similar that they certainly seem conspecific. From *varians* (formerly *auriculatus,* see Schwartz 1960) and *auriculatoides*, *bakeri* (as a species) differs in shape and size of the vomerine teeth, shape of the head, and in coloration.

The orcutti group

In the original description, the slightly-webbed Hispaniolan species *E. semipalmatus* was compared with *E. montanus* of the *varians* group, which was regarded as possibly the nearest relative. Although this may be the closest relative in Hispaniola, the webbed forms from the other islands, *orcutti, karlschmidti, brevipalmatus, cuneatus,* are still closer. *E. orcutti* of Jamaica may be the nearest relative of all. Although the feet are more extensively webbed and the back perhaps more warty, the size larger, and the color different in *orcutti*, it has in common with *semipalmatus* distinctly webbed feet, slightly granular belly, large disks, and a similarly shaped snout. *E. karlschmidti* of Puerto Rico appears to be in the same group and shares the characters of the short vomerine teeth and large size with

orcutti. It differs in its nearly fully webbed feet and in being rather smooth above and below. *E. brevipalmatus* and *E. cuneatus* appear least webbed (nearest *semipalmatus* in this regard) but the webbing is distinct none the less, and at least *E. brevipalmatus* is also large.

E. brevipalmatus and, even more, *E. cuneatus*, however, differ from the other webbed West Indian forms in their long vomerine series which, though not as long as in *sierramaestrae, pictissimus* or *lentus*, are an approach to the latter's condition. The vomerine series of *E. cuneatus* are about as long as those of *E. ricordii ricordii*.

E. brevipalmatus and *E. cuneatus* are very closely related to each other and also closely related to *E. sierramaestrae* and by way of the latter connect up with the *ricordii* group. Thus *E. cuneatus* and *E. brevipalmatus* (with long vomerine series, smoother belly) would appear to form a transition to the *ricordii* group, while *semipalmatus* (short vomerine series, somewhat rugose belly) approaches the *varians* group. These webbed species may really have such an intermediate position between the two most widespread and important West Indian eleutherodactyl groups. It is more certain that with their distinctly webbed feet and large disks they appear to be sufficiently distinct to be regarded as a group of their own which may be known as the *orcutti* group.

Eleutherodactylus semipalmatus Shreve

Eleutherodactylus semipalmatus Shreve, 1936, Proc. New England Zool. Club, 15: 94. Type locality: northern and eastern foothills of the Massif de La Hotte, 1000-4000 ft. P. J. Darlington coll.

Eleutherodactylus semipalmatus: Cochran, 1941, p. 72.

New records. **Furcy:** MCZ 31822-42, E. E. Williams and A. S. Rand coll., August 9, 1959; MCZ 33544-5, YPM 680-681, Luc Whiteman coll., May, 1960; MCZ 34482-8, Luc Whiteman coll., March, 1961; USNM 121031, 121493-4, 121463, 121566, A. Curtiss coll.

Recognition marks: a frog of small size with very large digital disks and with webbing apparent as a distinct fringe along each of the digits.

Discussion. The Furcy series seems somewhat darker than the unique type from the La Hotte range. Much of this darkening may be attributed to formalin; however, three of the USNM specimens seem unblackened and are nevertheless more heavily

marked than the type. The difference, however, is slight and with the La Hotte population represented by a single specimen there is no present evidence for the separation of a race. The largest specimen of the Furey series has a head and body length of 28 mm., identical with that of the La Hotte type.

The ricordii group

We characterize the *ricordii* group by the combination of the following characters: long vomerine series, enlarged disks, smooth belly. There is modest but not extreme range in size. We include here, though perhaps they deserve to be at least a subgroup, the larger gland-bearing species of Hispaniola, i.e. *glandulifer*, *darlingtoni* etc., including one new species here described, but excluding the small species *glandulifcroides*. Gland-bearing species are unique to Hispaniola among West Indian eleutherodactyli and we can provide no explanation for the presence of two groups of gland-bearers on this island and this island only.

Eleutherodactylus armstrongi Noble and Hassler

Eleutherodactylus armstrongi Noble and Hassler, 1933, Amer. Mus. Novitates, no. 652, p. 2. Type locality: "El Proprio Espuerzo," a coffee finca near Barahona, 1800 ft., Dominican Republic.

Eleutherodactylus armstrongi: Cochran, 1941, p. 79.

New records. **Morne La Visite, La Selle Range:** MCZ 21596, P. J. Darlington coll., 1934; USNM 117037, 118859-60, A. Curtiss coll. **Furcy:** MCZ 26778, A. Curtiss coll.; MCZ 31728, E. E. Williams and A. S. Rand coll., August, 1959; MCZ 33588-94, YPM 663-669, Luc Whiteman coll., May, 1960; MCZ 34362-78, Luc Whiteman coll., March, 1961; AMNH 55088, 55091, USNM 117117, 118850-1, A. Curtiss coll.; INHS 9491, M. Sanderson coll. **Morne Bourette:** USNM 118860-62, A. Curtiss coll.

Recognition marks: a frog of moderate size with large digital disks; on back a broad dark band bordered by white streaks, the band tending to disappear posteriorly, flanks tending to be dark or mottled; *vomerine teeth, long, extending well beyond outer margins of choanae.* The general pattern is amazingly similar to that of *bakeri hcminota; armstrongi* is generally darker in hue, especially on the flanks, and the two white lateral streaks are consequently more prominent, but the vomerine teeth provide the most reliable character for easy separation of the two species.

Discussion. No differences are apparent between these specimens and the paratypes from the vicinity of Barahona. La Selle Range, however, is essentially continuous with the Sierra of Baharueco at the east end of which the type locality "El Proprio Espuerzo" lies. The occurrence of the species at Furey and La Visite is thus not unexpected.

On the basis of its major structural features this species may be considered a member of the *ricordii* group characterized by long vomerine series and smooth belly. The disks, however, are larger than those of the "inner circle" of this group which only possess moderately enlarged disks, as in *pictissimus* and *furcyensis*. There is a similar situation in Cuba where *sierramaestrae,* included in the *ricordii* group, is a large-disked form.

The color of *armstrongi*, with light dorsolateral streaks with darker markings between them (and also to some extent outside them), is not far removed from the type of coloration shown by *pictissimus,* but, strange to say, as remarked above, there is a closer resemblance between the coloration of *armstrongi* and *E. bakeri heminota*, a member of the *auriculatus* group. This, however, is regarded as a parallel development and not an indication of relationship. The reasons for so striking a similarity between these frogs, not very closely related and occurring side by side, are quite unknown.

Eleutherodactylus furcyensis sp. nov.

Type. Museum of Comparative Zoology 34307, a gravid female, from **Furcy, Republic of Haiti,** collected by Luc Whiteman, March 17, 1961.

Paratypes. **Furcy:** MCZ 31585-7, E. E. Williams and A. S. Rand coll., August 7-9, 1959; MCZ 33533-43, YPM 670-679, Luc Whiteman coll., May, 1960; MCZ 34308-61 (+ 5 dupl.), Luc Whiteman coll., March, 1961; USNM 118844-9, 121024, 123370, 123796, A. Curtiss coll. **Morne La Visite:** USNM 117034-5, 117038-40, 117119, 118856-7, A. Curtiss coll.

Diagnosis. Allied to *E. weinlandi* Barbour and *E. pictissimus* Cochran, differing in the more warty dorsum and the coarser granulation at the side of the belly, the slightly differently shaped snout, and in coloration. Also allied to *E. armstrongi* Noble and Hassler, differing in having the dorsum more warty, and smaller, less truncate digital disks, and in coloration. Degree of wartiness in preserved specimens is of course subject to considerable modification.

Recognition marks: a frog of moderate size with small digital disks and vomerine series extending beyond the outer margin of the choana; general coloration dark, *lower lip bordered by dark spots,* belly spotted, back nearly uniform except for two short, white dorsolateral streaks.

Description of type. Tongue subelliptic, entire; vomerine teeth in two long, closely approximated, forwardly arched series behind the choanae and extending laterally beyond their outer borders; snout conical, somewhat rounded, a little longer than the orbital diameter; canthus rostralis moderate; nostril much nearer tip of snout than eye; loreal region somewhat oblique, concave; interorbital space broader than the upper eyelid; tympanum distinct, its greatest diameter a little more than one-half the greatest diameter of the eye; disk of third finger about a third the size of the tympanum; fingers moderate, first shorter than second; toes moderate, first much shorter than second, a slight rudiment of web, disks of both fingers and toes small, subarticular tubercles well developed; plantar surfaces studded with small tubercles; two small metatarsal tubercles; the tibiotarsal articulation of the adpressed hind limb reaches to the anterior border of the tympanum; warty above, warts small; below smooth, except for coarse granulation at the sides of the belly.

Coloration in alcohol. Above, dark gray; a black interorbital bar preceded by light gray on snout; upper lip whitish, bordered with a row of large black or dark brown spots which tend to coalesce, becoming obscure anteriorly; two small, white spots on rear of head; two narrow, white dorsolateral streaks, bordered with black, beginning a little behind the level of the insertion of the fore limbs and extending less than half way to that of the hind limbs; a few obscure black or very dark brown spots on the dorsum including lightened portion of forehead and snout, particularly posteriorly and at the sides; femur brown, cross barred, distal end of rear, and proximal end of front of femur red; fore limbs, tibia, and tarsus obscurely crossbanded with black or dark brown. Below, whitish; chest, throat, and under side of lower jaw stippled and spotted with dark brown; *a row of prominent dark brown or black spots at the edge of the lower lip.*

Paratype variation. Paratypes are so numerous that no attempt is made to include their variation after each item of the description. However, the following slight variations were noted: The tongue is sometimes slightly nicked, the vomerine teeth in some (probably confined to subadult individuals) do not extend

laterally beyond outer borders of choanae, the greatest diameter of the tympanum is a half to about two-thirds the diameter of the eye, and the tibio-tarsal articulation reaches as far as slightly beyond the anterior border of the eye.

The paratypes show essentially the same coloration as the type. The most noticeable variation is reduction of the barring of the femur. The dorsal markings also, either light or dark, may be obsolete or absent, and the ground color very dark, perhaps due to the method of preservation. USNM 118844 is decidedly pale but shows the characteristic markings.

USNM[1] 121001 is referred here with some doubt. While this animal shows the rather warty dorsum, the smooth belly, the moderately enlarged disks, and the long series of vomerine teeth and general resemblance in structure to *furcyensis,* the color is not the same. Like USNM 118844 this is relatively pale and to about the same degree. The most important difference in USNM 121001 (not shared by 118844) is the absence of the blackish spots on the lips, particularly the lower, and also on the underside of lower jaw, throat, and chest; the brown powdering on which the spots are usually superimposed is present. The hands and feet are nearly white. Dorsal dark markings appear at a minimum, with the short, white dorsolateral streaks seemingly absent.

Measurements. Type, head and body length, 36 mm. The same measurement for the largest paratype, 37 mm. (MCZ 31585).

Discussion. The MCZ has a single specimen from the vicinity of Jeremie which somewhat resembles this species and may be its La Hotte region representative.

Color in life of a Furcy specimen (presumably USNM 121024) from a letter by Anthony Curtiss (December 22, 1944):

"Body golden olive above, variegated with black; lips and throat whitish with black dots, the dots on the lips more vivid, those on the throat less clear; the belly and thighs tinged with pale yellowish green. Red in the groin and on the hind thighs . . ."

Eleutherodactylus pictissimus Cochran

Eleutherodactylus pictissimus Cochran, 1935, Proc. Boston Soc. Nat. Hist., 40: 371. Type locality: Tardieu (*ca.* 3000 ft.), Massif de la Hotte, Haiti.

Eleutherodactylus weinlandi Barbour (part), Haitian specimens only, Cochran, 1941, p. 51.

1 From Furcy, collected by A. Curtiss.

New records. **Furcy:** MCZ 3123, W. M. Mann coll., 1913; MCZ 31820, E. E. Williams and A. S. Rand coll., August, 1959; USNM 121018, A. Curtiss coll. **Diquini:** USNM 140216-7, W. G. Lynn coll. **Cave at Diquini:** USNM 117287, A. Curtiss coll. **Port-au-Prince:** AMNH 44009-10, 55136; USNM 117141, 118832-5, 120968-9, A. Curtiss coll. **Ça-Ira near Leogane:** MCZ 34489-99, Luc Whiteman coll., March, 1961. *Doubtfully referred:* MCZ 24289, 18 mi. N. Port-au-Prince, Angelo di Benedetto, coll. April, 1939. A very small specimen without strong pattern.

Recognition marks: a frog of moderate size with small digital disks and with vomerine teeth extending well beyond outer choanal margins, *back and limbs boldly and rather uniformly mottled,* except for two narrow dorsolateral light lines. Lower lip and whole underside unmarked.

Discussion. These specimens are referred to *pictissimus* Cochran, which we regard as a southwest peninsular population related to, but distinct from, *weinlandi* of Hispaniola north of the Cul de Sac Plain. Lynn (1958) has already referred the Diquini specimens listed above to this form. In addition to the type from the Massif de la Hotte and the specimens listed above from the Port-au-Prince region, there are now specimens in the MCZ of this form from the neighborhood of Aux Cayes and of Jeremie.

Examination of MCZ material of *pictissimus* Cochran, *lentus* Cope, *weinlandi* Barbour, *ricordii ricordii* Duméril and Bibron and of the recently described species *bresslerae* shows surprisingly few differences, even in coloration. All are of moderate size (to 41 mm.). Though the type of *weinlandi* as preserved differs from *pictissimus* in the very dark dorsum and the relatively unmarked hind limbs, in other specimens the coloration of both back and hind legs may be much like that of *pictissimus* even at or near the type locality of *weinlandi* (Puerto Plata, Dominican Republic). Indeed, *pictissimus* and some examples of *weinlandi* (e.g. MCZ 23526, Puerto Plata, MCZ 23548-50 (+ 2 dupl.), 25 km. by road south of Puerto Plata) appear virtually identical *as preserved* with examples of *lentus* from various islands of the Virgin group. On this evidence it might appear justifiable to synonymize *pictissimus* Cochran and *weinlandi* Barbour with *lentus* Cope. However, specimens from the several areas are much more distinct in life. Chapman Grant (1937) in a discussion of *lentus* points out that St. Thomas specimens have

1 He suggests also that St. Thomas specimens are larger than St. Croix specimens, but this, as he indeed suspected, was an artifact of collection. MCZ 3635 from Fredericksted, St. Croix, has a head and body length of 35 mm.

much more yellow than those from St. Croix and mentions also red coloration under rear of thighs.[1] Mertens (1939) describing *weinlandi* from several localities in the Dominican Republic cites a lively brick red ("lebhaft ziegelrot") coloration as conspicuous on the posterior dorsum and whole upper side of the hind limbs with the exception of the toes. In contrast, Lynn (1958) describing *pictissimus* from Diquini observed only "a yellowish cast on upper surfaces of arms and legs." Such differences in coloration of the living animals certainly require us to retain these forms as distinct. Nevertheless, the overlap in characters in all other respects would suggest to us — given only the Hispaniolan evidence — that these differences are infraspecific. Mertens (1939) has already proposed such a relationship for *lentus* and *weinlandi*, explicitly designating the latter as *E. lentus weinlandi*.

However, the relation of this complex to the Cuban forms cited above is difficult to evaluate. *E. bresslerae* Schwartz from the vicinity of Baracoa looks strikingly like *weinlandi* Barbour. As tends to be true in the latter form the hind limbs of *bresslerae* are less strongly marked than in *pictissimus*. *E. ricordii ricordii* (*sensu* Shreve 1945, p. 117) usually lacks the dorsolateral light lines present in the forms previously discussed, and the hind limbs tend to be densely but relatively finely spotted and the dorsal spots tend to coalesce less often. Both *bresslerae* and *ricordii ricordii* have vomerine teeth averaging slightly shorter than in the Hispaniolan or Virgin Island forms.

It is evident therefore that *pictissimus* is somewhat closer to *weinlandi* and to *lenthus* than to *ricordii ricordii* or *bresslerae*. Still, the difference in vomerine teeth upon which we base this statement is neither so great nor so consistent as to imply (for us at least) specific status, and the color differences between *pictissimus* and *weinlandi-lentus* (red on thighs in the latter) are greater than between *pictissimus* and *ricordii* or *bresslerae* in none of which is the groin ever red.

There is a further problem in that the two Cuban forms in question, *bresslerae* and *ricordii ricordii*, are regarded by Schwartz as specifically distinct from one another. The evidence on species distinction here seems to rest on the occurrence sympatrically with *bresslerae* (and with *acmonis* Schwartz, a smaller form very similar to *ricordii ricordii*) of the small lowland *ricordii planirostris*. However, Schwartz (1960a, p. 25) very explicitly states that he has seen no intergrades between any of the races of *ricordii* recognized by him. It seems to us possible, therefore, that there may be two species or groups of

species — one of moderate size typified by *ricordii, sensu stricto,* and one a small size typified by *planirostris.*

Bresslerae would clearly belong to the series of larger forms, as presumably would *ricordii goini* Schwartz 1960. *Acmonis* Schwartz would be a representative of the smaller or *planirostris* series, and indeed Schwartz has suggested (p. 45) that "*acmonis* may be a local stock which differentiated from *planirostris* in the Yunque uplands."

If there are two such series of the *ricordii* complex in Cuba, *pictissimus* would presumably belong with the series to which *ricordii* in the strict sense belongs, with *weinlandi* and *lentus* probably belonging in this series too.

However, in every aspect of the interpretation of the subspecies-species status of the forms of this complex there are so many uncertainties that in the end we have pusillanimously elected to allow the nomenclatural situation to stand as we found it. We retain *pictissimus* as a full species, there being no solution that appears to us clearly better.

Color in life. Lynn, 1958, based on a specimen from Diquini: "Back light tan with a pinkish cast; a dark brown blotch between the eyes with a light interocular bar immediately behind it, three lines of irregular brown blotches along back; lateral lines of light tan from eye to groin; sides below lateral lines with two rows of irregular brown blotches; brown line along canthus extending through eye and curving down behind tympanum; upper surfaces of hind limbs with brown cross bars; yellowish cast on upper surfaces of arms and legs; belly white; throat with brown suffusions; lower surfaces of hands and feet brown."

Anthony Curtiss reports the color of a frog of this species caught at his house in Port-au-Prince May 31, 1944: "In life the upper parts were bright cinnamon buff marbled with blackish, the lengthwise one on each side of the back not differing in color from the general ground color of the upper parts." He describes the noise of this same frog: "It made a noise resembling the chirping of a cricket, a noise I had often heard of late since the rains began, but which I believed to be caused by some insect until this evening this small frog uttered it in my hand." He comments further on the habits of the species: "As it is nocturnal (never emerging until the sun has been down for an hour or so), small and retiring, it may have escaped notice. . . . It certainly never occurred to me that Eleutherodactyli were living and breeding under this house."

In a later letter (August 14, 1944) he further remarks: "The

later rains have now commenced and the small frogs of Port-au-Prince *'Eleutherodactylus weinlandi'* [= *E. pictissimus*] are emerging again, as they do at the beginning of the early rains. I mean that the adults are emerging, for I have seen no young so far this month (I sent you some in May.)."

Eleutherodactylus darlingtoni Cochran

Eleutherodactylus darlingtoni Cochran, 1935, Proc. Boston Soc. Nat. Hist., 40: 368. Type locality: near La Visite, La Selle Range, Haiti, 5000-7000 ft.

Eleutherodactylus darlingtoni: Cochran, 1941: 43.

New records. **Near Morne La Visite, La Selle Range:** MCZ 21950-1, P. J. Darlington coll., 1934. **La Selle Ridge on Sal Trou Road:** AMNH 44031, W. G. Hassler coll., 1935.

Recognition marks: a frog of moderate size, digital disks large, vomerine series short, with glandular swollen areas above forelimb, in front of thigh and on posterior edge of thigh near knee. Color dark, uniform.

Discussion. Four specimens are known in addition to the five belonging to the type series described by Cochran 1941. All appear to come from the highest parts of the La Selle Range. MCZ 21950-1, though unrecorded by Cochran, have the same data as the type series. The Hassler specimen, with the data "La Selle ridge on Sal Trou Road," is less precisely localized but it may be inferred that the approximate crest of the ridge is implied.

Eleutherodactylus leoncei[1] sp. nov.

Type. Yale Peabody Museum 1167, a gravid female taken under a log in pine and hardwood forest, **Forêt des Pins near Morne La Selle, Republic of Haiti.** P. S. Humphrey coll., February 26, 1959.

Paratypes. YPM 1168-1201, MCZ 31964-8, various localities in the **Forêt des Pins,** near Morne La Selle, Republic of Haiti. P. S. Humphrey coll., February 19-March 10, 1959. Under logs in pine and hardwood forest. MCZ 21592, **Near La Visite, La Selle Range,** 5000-7000 ft., Republic of Haiti, P. J. Darlington coll., September 16-23, 1934.

Referred specimens: INHS 5237-40, **Refuge, La Selle Massif,** M. Sanderson coll. AMNH 44171-6, 44178-86, **La Selle ridge on Sal Trou Road,** W. G. Hassler coll.

1 Named in honor of M. Leonce Bonnefil Fils.

Diagnosis. From *E. darlingtoni* Cochran, apparently the closest relative, which has been collected with it, the new form differs in the less angled vomerine teeth, smaller digital disks, possible smaller size and much less uniform coloration. Also apparently allied to *Eleutherodactylus glandulifer* Cochran from the Massif de La Hotte but differing in the more truncate disks on fingers and toes, a slightly shorter snout and broader head, less distinct glands, probable smaller size, and coloration.

Recognition marks: a frog of moderate size, *digital disks not large*, with short vomerine series and glandular areas as in *darlingtoni* (*q.v.*). Color above and below strongly mottled.

Description of type. Tongue suboval, slightly nicked behind; vomerine teeth in two long groups each a bit forwardly curved medially, located behind the choanae, and both series somewhat obliquely directed backward, slightly separated on the median line, and extending about to a level with the outer borders of the choanae laterally; snout subacuminate, longer than the diameter of the eye; canthus rostralis ill defined; loreal region concave, rather oblique; nostril nearer tip of snout than eye; interorbital space much broader than upper eyelid; tympanum distinct, about two-thirds the diameter of the eye, digital disks enlarged, especially so on the two outer fingers, truncate; disk of third finger about one-half the size of tympanum; first finger shorter than second; first toe shorter than second; toes very slightly webbed with a vestige of dermal fringe; two metatarsal tubercles; the tibiotarsal articulation of the adpressed limb reaches the eye; finely warty above; smooth below; a large suboval gland on each flank just in front of the hind limb, also an elongate gland on the rear of each femur occupying a bit more than half its length and beginning near the knee; in addition to these, a rounded gland with a smaller one below it behind the tympanum on each side and near the insertion of the forelimb.

Because of the large number of paratypes it has not seemed worthwhile to record every deviation from the condition of the type. Variation in fact does not seem to be excessive. The tympanum varies between about half to three-quarters the diameter of the eye. The enlargement of the digital disks may be scarcely noticeable in the more immature, which reflects the fact that the disk of the third finger may be less than half the diameter of the tympanum. In some of the immature specimens the glands may be entirely indistinguishable or obscure. Variations in coloration are listed below.

Coloration in alcohol. Above, ground color gray, but almost concealed by dark brown mottlings and spottings sometimes in the form of short longitudinal bars, a bar, more or less distinct, connecting the eyelids. Two whitish spots, lighter than the ground color, each above the scapular region and bordered by the dark brown of the dorsal markings. Ground color of upper side of thighs lighter than that of dorsum and less heavily marked; a tendency for markings of hind limbs to form into bars. All glands either somewhat orange or white (apparently white where the orange has faded) also heavily mottled and spotted with dark brown. Below, whitish, throat and chest suffused with dark brown and belly reticulated with the same color, and underside of limbs somewhat dotted, mottled, and suffused with the same.

The marking on the dorsum is sometimes less profuse in the paratypes than in the type. Some examples have definite bands on the hind limbs. The shade of the dorsal ground color varies to some extent, with one example (MCZ 21592) showing a brown mixture with the gray, probably due to difference in preservation. A few examples go to the extreme of having the dorsum so dark that no markings can be made out except the whitish spots above the scapular region, which also are occasionally absent. Below, there is much variation in the markings ranging all the way from a slight dusting of brown, including the belly, to the condition seen in the type, sometimes the belly reticulation being reduced to spots or mottling as an intermediate condition.

Color in life. Color notes were taken by Sarita Van Vleck for most of the very large series collected by Humphrey. These are paraphrased below.

YPM 1197 was described as dorsally green buff, heavily and irregularly mottled with olive. Two light buff spots just behind head. Snout greenish, upper lips copper. Venter transparent gray with orange on ventral side of femur.

In YPM 1170 the ground color dorsally is described as pale pink with the spots above the scapular region as white. YPM 1182 was "buff bronze lightly mottled with dark brown and gold." Below, the coloration is represented in various examples as green, pale green, pale blue, and pale yellow. The under surfaces of the hind limbs are described as orange red, and red, with the extent of the color quite variable. In one example (MCZ 31964) this color was apparently very extensive: ". . . hands have yellow and orange pads, leg linings and groin bright

orange." When first preserved, some of the specimens, including the type, had a red suffusion on the underside of the hind limbs, the remnant of the color just mentioned. Now, even this has disappeared.

Measurements. Type, head and body length, 36 mm. The same measurement for the largest paratype, 37 mm.

Discussion. Paratype MCZ 21592, an immature, was formerly doubtfully referred to *E. darlingtoni* and was with three undoubted members of that form, all with the same collecting data.

This species was collected in the same situations as *E. audanti* (see above).

The dimidiatus group

E. jugans seems to be quite closely related to *E. albipes* of Pico Turquino, Oriente, Cuba, and, by way of the latter, to *E. emiliae* of central Cuba. *E. jugans* thus seems clearly to belong, along with the Cuban species, in the *dimidiatus* group — a group characterized by the combination of moderately large size, long vomerine series, undeveloped digital disks, and frequently stocky build (the last not marked in *dimidiatus* itself).

The closest relative of *E. jugans* within Hispaniola is *E. ventrilineatus* which differs from *jugans* and the *dimidiatus* group in its short vomerine tooth series. In this character *E. ventrilineatus* must be considered only a peripheral member of the *dimidiatus* group and perhaps annectant to the *varleyi* group.

Eleutherodactylus jugans Cochran

Leptodactylus darlingtoni Cochran, 1935, Proc. Boston Soc. Nat. Hist., 40: 372 (part). Type locality: near La Visite, La Selle Range, Haiti, between 5000 and 7000 ft.

Eleutherodactylus jugans Cochran, 1937, Journ. Washington Acad. Sci., 27: 312.

Eleutherodactylus jugans: Cochran, 1941, p. 33.

Recognition marks: a small frog with almost no digital dilatations and vomerine series heavy, extending far laterally beyond choanae. Ground color dark, uniform above, below with white spotting coarse and anastomosing on belly, spots fewer and farther apart on throat and limbs.

Discussion. No specimens have been taken since the original series. This species was not obtained by Humphrey on his visit to the Forêt des Pins. Its ecology is not known.

The varleyi group

In the Port-au-Prince region we regard a single species as belonging to this group. Our argument for this conception is as follows:

Eleutherodactylus glanduliferoides appears to be closest to *E. cubanus* of Pico Turquino, Oriente, Cuba, and to the recently described *E. phyzelus* Schwartz of Pinar del Rio, Cuba. The Cuban forms are strikingly similar to *glanduliferoides* in size and general habitus and sometimes possess or approach the type of coloration that appears to be characteristic for *glanduliferoides*. Both differ from *glanduliferoides* in the absence of the glands at the rear of the hind limb, in the inguinal region, and in the axilla, the presence of which, when *glanduliferoides* was first described, led to the comparison of this Hispaniolan species with the other gland-bearing Hispaniolan forms.

We are now, however, inclined to place very little emphasis on the presence or absence of glands except as a species character. Such other gland-bearing species as *glandulifer, darlingtoni* or *leoncei* are very much larger (40-50 mm. instead of 15-16 mm.), have larger disks, and much longer vomerine series.

Instead, we now regard *E. glanduliferoides,* along with *E. cubanus* and *E. phyzelus,* as members of the *varleyi* group, which we characterize by the short vomerine series, the barely enlarged digital disks, and small size. *E. varleyi* itself, a common lowland form in Cuba, is less similar to *glanduliferoides* than the two other Cuban species mentioned and differs from them and from *glanduliferoides* in the presence of dorsolateral folds, a character which provides a transition to *E. minutus* of Hispaniola.

E. minutus, however, appears to intergrade with *E. abbotti,* a somewhat larger form, which because of its enlarged disks, is placed in the *varians* group. The *minutus-abbotti* complex thus seems a true annectant between the *varians* and *varleyi* groups.[1] Related to this complex are the small eleutherodactyli of Puerto Rico, *E. gryllus* and related forms and *E. brittoni,* the latter with slightly smaller disks, approaching the *varleyi* group more than the others. This rather complex pattern of relationships (or at least resemblances) is best understood by reference to Table 4.

1 Dunn (1925) in describing *varleyi* compared it with *minutus* and *abbotti.*

TABLE 4

Characters of certain *Eleutherodactylus* species.

	glanduliferoides	*cubanus*	*phyzelus*	*varleyi*	*minutus*	*brittoni*	*abbotti*
glands	+	−	−	−	−	−	−
dorsolateral folds	−	−	−	+	+	−	+
digital disks	almost absent	almost absent	almost absent	almost absent	almost absent	somewhat enlarged	enlarged
vomerine series	short	short	short	larger but still short	short	short	short
glanduliferoides pattern	+	+ −	+ −	±	−	−	+ −
size (in mm.)	16	13	15	14	17.5	16	21

Eleutherodactylus glanduliferoides Shreve

Eleutherodactylus glanduliferoides Shreve, 1936, Proc. New England Zool. Club, 15: 96. Type locality: near La Visite, La Selle Range, Haiti, 5000 to 7000 ft.

Eleutherodactylus glanduliferoides: Cochran, 1941, p. 45.

New record. **N. Slope Morne La Visite,** USNM 117133, A. Curtiss coll.

Recognition marks: a very small frog with small digital disks, vomerine series short, not extending beyond outer borders of choanae, with glandular areas above forelimb and on thigh. A narrow white dorsomedian line on a median, dorsal, broad dark band, the light line continued by lines on the posterior edges of the thighs.

Discussion. This species, until now known only from the type and paratype, is represented by a well preserved nearly topotypic Anthony Curtiss specimen which in size (head and body length 16 mm.), structure, and coloration almost exactly resembles the type. The most important variations in color are the following: the median dorsal brown band and the enclosed narrow white line continue to the end of the body, at which point the white line is joined by the somewhat broader streaks on the posterior sides of the femora. There is somewhat more spotting on the throat than in the type.

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PLATES

Plate 1. *Eleutherodactylus bakeri heminota.* Type, M.C.Z. 31734. Dorsal view. N. Strekalovsky del.

Plate 2. *Eleutherodactylus furcyensis.* Paratype, M.C.Z. 31585. Dorsal view. N. Strekalovsky del.

Plate 3. *Eleutherodactylus furcyensis.* Paratype, M.C.Z. 31585. Ventral view. N. Strekalovsky del.

Plate 4. *Eleutherodactylus leoncei.* Paratype, M.C.Z. 31694. Dorsal view. N. Strekalovsky del.

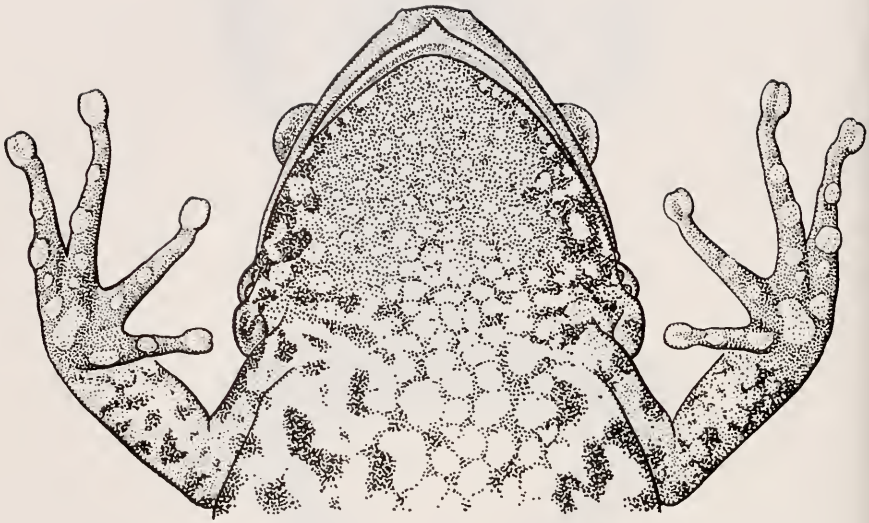

Plate 5. *Eleutherodactylus leoncei.* Paratype, M.C.Z. 31964. Ventral view of head and forelimbs. N. Strekalovsky del.

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THE NECK MUSCULATURE OF A CRYPTODIRE (*DEIROCHELYS*) AND A PLEURODIRE (*CHELODINA*) COMPARED.

By R. V. Shah

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CAMBRIDGE, MASS., U.S.A.
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No. 6 — *The Neck Musculature of a Cryptodire* (Deirochelys) *and a Pleurodire* (Chelodina) Compared

By R. V. Shah

The difference in the mode of bending of the neck in chelonians has been used as a chief character for the subdivision of the class Chelonia into subclasses Cryptodira and Pleurodira. The neck in the former subclass bends in an 'S' shape when the neck is retracted under the shell, while the neck in the latter bends laterally and is pulled under the edge of the shell. Vallois (1922) while describing the episomal musculature in vertebrates has given an account of the epaxial muscles of cryptodiran and pleurodiran turtles. In order to understand the full mechanism of the neck movements in cryptodiran and pleurodiran forms, a detailed study of the head and neck muscles in *Deirochelys* as a representative of cryptodires and *Chelodina* as a representative of pleurodires is presented here, and the muscles are compared with the head and neck muscles of *Lissemys* and *Testudo* as worked out by George and Shah (1954, 1955).

The *adductor mandibulae* in Chelonia, according to Owen (1866), Edgeworth (1935), and George and Shah (1954, 1955), consists of three main parts, viz., the *adductor mandibulae externus*, the *adductor mandibulae medius* and the *adductor mandibulae internus*. However, according to Schumacher (1956) there are only two main parts, viz., the *adductor mandibulae externus* and the *adductor mandibulae internus*, and these are again subdivided into three each. The present investigation shows that, as in *Lissemys*, the muscles in *Chelodina* and *Deirochelys* consist of three main separate bellies with their fibres running in different directions and having separate insertions.

The *adductor mandibulae externus* in *Deirochelys* (Figs. 1, 3, Ad.M.E.) and *Chelodina* (Fig. 6) is similar to the one found in all the chelonians as a major adductor muscle of the lower jaw. The muscle has a very wide area of origin: the fibres arise from the inner surface of the squamosal and quadrate, the dorsal surfaces of prootic and opisthotic and from the side of the occipital crest and the parietal bone. The fibres arising from the squamosal and quadrate run forward and inward.

They decussate with those arising from the rest of the areas mentioned above. After decussation all join together to form a single massive muscle which runs vertically downward through the temporal fossa toward the coronoid process of the mandible.

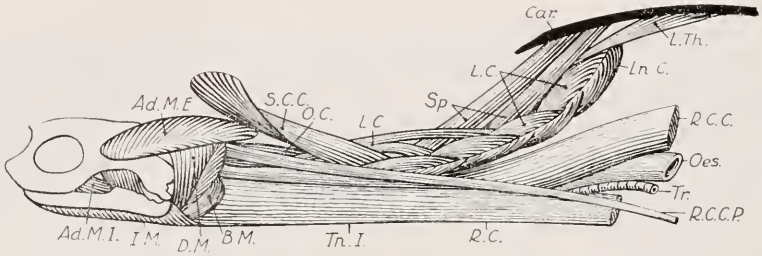


Fig. 1. Lateral view of the head and neck of *Deirochelys* with *constrictor colli* muscle removed.

The insertion is partly fleshy and partly tendinous. The muscle shows an almost identical pattern of origin, course and insertion in *Chelodina* and *Deirochelys;* it differs in the place of decussation of the fibres. In *Deirochelys* the line of decussation is very much closer to the squamosal and quadrate, whereas it is almost in the middle of the body of muscle in *Chelodina.*

The *adductor mandibulae medius* (Figs. 3, 7, Ad.M.M.) lies under the *adductor mandibulae externus.* It arises from the lateral side of the parietal and the anterior side of the prootic. The fibres run vertically downward and converge to insert on the posterior inner side of the coronoid process of the lower jaw. The muscle in both the animals, *Chelodina* and *Deirochelys,* is almost identical in its origin, course and insertion. It is an adductor of the lower jaw.

The *adductor mandibulae internus* (Figs. 1, 3, Ad.M.I.) is the smallest of the three adductors and is the innermost in position. In both genera it arises from the upper surface of the pterygoid and its trochlear process. The fibres run backward and converge to form a narrow muscle belly which finally inserts on the posterior end of the articular bone. In *Deirochelys* the median fibres of the muscle decussate with the anterior fibres of the *adductor mandibulae medius* but this decussation does not occur in *Chelodina.* The muscle in both the animals acts as an adductor of the lower jaw.

The *depressor mandibulae* in *Deirochelys* (Figs. 1, 3, D.M.) and in *Chelodina* (Fig. 6) arises by two heads, one from the lateral outer border of the squamosal and the posterior border of the tympanic capsule, the other from the fascia covering the neck muscles at the base of the skull. The fibres of both heads decussate to give a pinnate appearance to the muscle. The muscle runs downward to insert on the outer lower surface of the articular bone of the lower jaw. The fibres arising from the fascia are comparatively fewer in *Chelodina* than in *Deirochelys*. The muscle acts as a depressor of the lower jaw.

The *intermandibularis* in both genera (Figs. 1, 3, Im.) forms a thin sheet of muscle stretched between the two rami of the mandible. The fibres arise from the inner surface of the lower border of the mandibular rami and meet their fellows of the other side in the midline. At their point of union they form a median raphe. In *Chelodina* the fibres of the anterior fourth of the muscle do not meet their counterparts of the other side but instead end in an oval tendinous plate which continues the median raphe formed by the rest of the fibres. There is no such tendinous plate in *Deirochelys*. As a result of the contraction of this muscle the floor of the buccal cavity is raised, and on its relaxation the floor of the buccal cavity is lowered. This movement of the floor of the buccal cavity helps in the process of deglutition and to a certain extent to draw air in for olfaction as suggested by McCutcheon (1943).

The *constrictor colli* forms a superficial sheath of muscle on the neck. In *Chelodina* (Fig. 6, C.C.) and in *Deirochelys* (Fig. 3, C.C.) the entire neck is ensheathed, unlike *Lissemys* where it is only partly covered by the muscle (George and Shah, 1954). The muscle in both the animals arises by two heads, a temporal and a cervical. The former arises from the upper outer border of the squamosal and the dorsal fascia at the level of the posterior end of the occipital crest, while the latter arises from the lateral side of the neural arches of the 3rd to 6th cervical vertebrae. Fibres of both the heads run laterally downward to the ventral side of the neck where they meet their fellows of the opposite side in the mid-ventral line and form a median raphe. The median raphe of the *intermandibularis* is a continuation of the median raphe of the *constrictor colli*. The latter muscle gives compactness to the neck and keeps all the long neck muscles in their respective places.

The *branchiomandibularis* (Figs. 1, 3, 6, B.M.) in both genera arises from the anterior, dorsal, and the ventral surfaces of the distal end of the anterior cornu of the hyoid. The fibres run forward towards the posterior end of the lower jaw. In *Deirochelys* a few of the outer fibres decussate with posterior fibres of the *depressor mandibulae* while the rest of the muscle inserts on the lower border of the mandible just in front of the point of insertion of the *depressor mandibulae*. In *Chelodina* the whole muscle inserts on the mandible and there is no decussation of its fibres with those of the *depressor mandibulae*. On contraction of this muscle the anterior cornu is pulled forward and downward. When, however, the anterior cornu is firmly fixed as a result of the action of other muscles, the muscle acts as a depressor of the lower jaw to a certain extent. Besides this, the movements of the hyoid help in the process of deglutition.

The *genioglossus* (Figs. 3, 6, G.G.) in both genera is a very small muscle. It arises from the anterior end of the inner border of the dentary. It runs posteriorly towards the hyoid, and in *Deirochelys* it inserts partly on the anterior border of the basihyal and partly on the connective tissue that connects the hyoid with the lower jaw. In *Chelodina* it inserts only on the latero-ventral side of the basihyal. The muscle acts as a protractor of the tongue.

The *geniohyoideus* (Figs. 3, 6, G.H.) arises from the inner side of the mandibular symphysis. In *Chelodina* the origin is tendinous while it is fleshy in *Deirochelys*. The muscle in both genera runs posteriorly towards the hyoid where it is inserted on the inner curve at the proximal end of the anterior cornu. The median fibres of the muscles of either side decussate in the mid-ventral line, as seen in *Lissemys* and *Testudo* (George and Shah, 1954, 1955). When the muscle contracts it pulls the hyoid anteriorly which in turn helps in tongue movements.

The *hyoglossus* (Figs. 3, 6, H.G.) in both the animals arises from the anterior and the ventral surfaces of two-thirds of the length of the anterior cornu at its proximal side. The muscle, after its origin, splits up into a dorsal and a ventral part. The dorsal part of the muscle in *Deirochelys* is inserted on the lateral projection of the ceratohyal, while in *Chelodina* the similar part of the muscle is inserted on the lateral border of the ceratohyal. The ventral part of the muscle in both the animals runs anteriorly forward and is inserted on the connective tissue

which connects the hyoid with the lower jaw. The muscle acts as the retractor of the tongue and the hyoid. It also acts as a depressor of the tongue and the hyoid to a certain extent.

The *hypoglossohyoideus* is a peculiar muscle found only in Chelonia. In *Chelodina* and *Deirochelys* the muscle arises from the posterior end of the hypoglossum (entoglossum) and is inserted on the anterior cartilaginous projection of the hyoid. The muscle helps in bringing about some of the movements of the floor of the buccal cavity. In *Lissemys* and in *Testudo* there is an additional set of muscles besides the *hypoglossohyoideus,* the *hypoglossoglossus* (George and Shah, 1955). In *Chelodina* there is a small slip of muscle which arises from the inner surface of the mandibular symphysis and is inserted on the ventral side of the anterior end of the hypoglossum. There is no such muscle slip in *Deirochelys* or in *Lissemys* and *Testudo.* I venture to call this muscle slip the *hypoglosso-mandibularis.* When this muscle contracts it pulls the hypoglossum anteriorly, thus helping in protraction of the tongue.

The *intercornuatus* in *Deirochelys* is very thin and membranous like that found in *Lissemys;* it is fleshy and highly developed in *Chelodina.* The muscle in both animals runs obliquely inward from the anterior border of the posterior cornu to the posterior border of the anterior cornu. This muscle is responsible for bringing about intercornual movements.

The *constrictor hyoideus* in *Chelodina* (Fig. 6, C.H.) differs from that of *Lissemys* and *Testudo* in having a tendinous origin from the diapophysis of the 6th cervical vertebra. In the case of *Lissemys* it arises from the neural spine region of the 5th, 6th and 7th cervical vertebrae by three separate heads. In *Testudo* the muscle arises by a single fleshy head from the neural spine of the 7th cervical vertebra. In *Chelodina* as in *Testudo* the muscle runs forward and inserts on the posterior border of the distal half of the anterior cornu, but in *Lissemys* the three separate heads join to form a single flat muscle which runs forward and after a short distance again splits into three parts, each inserting separately. The muscle is absent in *Deirochelys.* It acts primarily as a retractor of the hyoid but in the case of *Lissemys* and *Testudo* it also acts as a retractor of the head and the neck under the shell.

The *spinalis cervico-capitis* in *Chelodina* is less extensive than that of *Deirochelys* (Fig. 1, S.C.C.) In *Chelodina* it arises from the posterior half of the neural spine of the 3rd, and of the entire

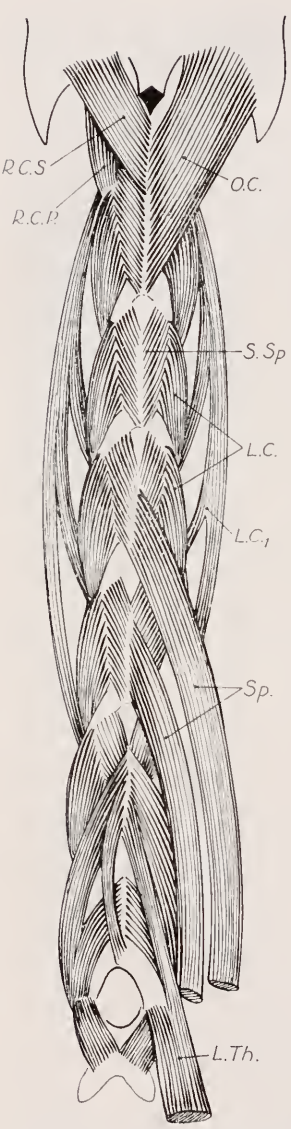
length of the spines of the 4th and 5th cervical vertebrae. In both animals the muscle runs obliquely forward and outward. The median fibres insert on the lateral side of the occipital crest while the rest of the fibres thin out into a tendinous aponeurosis which covers the *adductor mandibulae externus* musele from the dorsal side and inserts on the dorsal side of the parietal, postorbital and jugal and the upper surface of the squamosal. In *Lissemys* the muscle is more massive, having its origin from the neural spines of the 3rd to 6th cervical vertebrae, and it is still better developed in *Testudo* where it arises from the neural spines of the 2nd to 6th cervical vertebrae (George and Shah, 1954, 1955). The massiveness of the muscle appears to be in direct relation to the S-shaped bend of the neck which is greatest in *Testudo* among the three cryptodires described, viz. *Lissemys, Testudo* and *Deirochelys.* When the head and the neck are protracted the muscle keeps the head elevated and also brings about the lateral rotation of the head. In *Chelodina* there is no S-shaped bending of the neck and the muscle is not so highly developed. In this animal the action of the muscle is similar to that seen in *Lissemys, Testudo* and *Deirochelys.*

The *semispinalis* set of muscles in *Chelodina* (Fig. 7, S.Sp.) has a slightly different pattern of course and insertion than is seen in *Deirochelys.* In *Deirochelys* (Fig. 2, Sp.; S.Sp.) the muscle is present on the 2nd to 6th cervical vertebrae. For each of these vertebrae the muscle arises from the neural spine of one vertebra and runs obliquely forward and outward. The fibres of the posterior half of the muscle decussate with the median fibres of the *longissimus* muscle corresponding to the same vertebra to gain a common insertion on the posterior zygapophysis of the next preceding vertebra. The fibres of the anterior half of the muscle are directly inserted on the posterior rim of the neural arch of the next preceding vertebra. Such is the pattern of origin, course and insertion for all the *semispinalis* set of muscles; however, the muscles for the 1st, 7th, and 8th cervical vertebrae are absent. In addition to this set of muscles there are two pairs of muscles in *Deirochelys* that arise from the undersurface of the nuchal plate. The place of origin of one pair is just behind that of the other. The muscles of both anterior and posterior pairs after their origin run forward to insert on the neural spines of the 4th and 5th cervical vertebrae, respectively. These two pairs of muscles appear to belong to the *semispinalis system* (Figs. 1, 2, Sp.) of

muscles. The main function of these muscles is to act as a retractor of the head and the neck, and when these are protracted to keep the neck and the head elevated. These nuchal muscles are absent in *Chelodina*.

The *semispinalis* in *Chelodina* is present on the 2nd to 8th cervical vertebrae. The following is the typical pattern of origin, course and insertion of the muscles on all the vertebrae. The muscle corresponding to one vertebra arises from the neural spine of that vertebra and the fibres run forward and outward. All the fibres decussate with the median fibres of the *longissimus* muscle corresponding to the same vertebra to gain a common insertion on the posterior zygapophysis of the preceding vertebra. The *longissimus cervicis* in *Chelodina* has a complicated pattern and, since the *semispinalis* completely merges with it, the *semispinalis* set of muscles becomes quite different from that of *Deirochelys*. In *Deirochelys* the *semispinalis* has a double insertion while its insertion is single and indirect in *Chelodina*. In *Lissemys* also the *semispinalis* in combination with the *longissimus cervicis* forms a complicated system somewhat similar to the one seen in *Chelodina*, but the same muscle is very simple in *Testudo*. This intricate pattern of the muscle system is perhaps directly related to the length of the neck and its various movements. In *Deirochelys* the typical arrangement of the *longissimus cervicis* is as follows: The muscle corresponding to the 7th cervical vertebra arises from the anterior zygapophysis of the 8th vertebra and runs anteriorly. Its median fibres decussate with fibres of the *semispinalis* muscle corresponding to the 7th vertebra and finally gain a tendinous insertion on the posterior zygapophysis of the 6th vertebra. The muscles corresponding to the 6th, 5th, 4th, 3rd and 2nd cervical vertebrae show similar patterns of course, origin and insertion. There is a slight modification in the muscle which arises from the 8th cervical vertebra which, after its origin and running forward for a short distance, splits up into two bellies, an inner and an outer one. The former inserts on the anterior half of the neural spine of the 7th vertebra while the latter inserts on the anterior half of the neural spine of the 6th cervical vertebra.

Another set of muscles in *Deirochelys* appears to be part of the *longissimus cervicis* series but since their homology is doubtful they are described separately. These muscles lie on the latero-dorsal side of the *longissimus cervicis* of the 2nd to 5th cervical vertebrae. Thin muscle strips arise from each of the



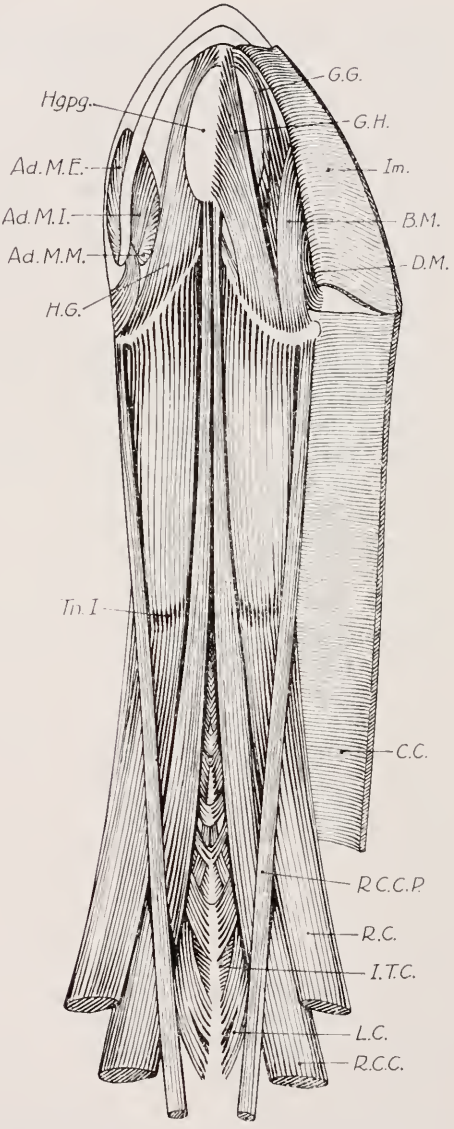


Fig. 2. *Left.* Dorsal view of the head and neck of *Deirochelys* showing epaxial muscles.

Fig. 3. *Right.* Ventral view of the head and neck of *Deirochelys* showing the superficial ventral muscles after reflecting the *constrictor colli* to one side.

anterior zygapophyses of 4th, 5th and 6th cervical vertebrae and merge with one another to form a single muscle mass which finally is inserted on the lateral projection of the neural arch of the first vertebra. When this muscle set of one side contracts, lateral flexion and rotation of the anterior cervicals and the head region is brought about.

The *longissimus cervicis* group of muscles in *Chelodina* (Fig. 7, L.C.) differs completely from that of *Deirochelys* (Fig. 2). In *Chelodina* there is much less evidence of segmental arrangement of the muscles such as was seen in *Deirochelys* or *Lissemys* or *Testudo* (George and Shah, 1955). Hence the description of the muscle corresponding to each cervical vertebra is necessary. The muscle corresponding to the 7th cervical vertebra arises from the anterior zygapophysis of the 8th vertebra, and after its origin splits up into two bellies, a lateral and a median one. The former gains its insertion on the posterior zygapophysis of the 6th vertebra while the latter inserts along with the *testocervicalis lateralis* muscle (Vallois, 1922, = *longissimus thoracis*, George and Shah, 1954, 1955) on the posterior zygapophysis and the diapophysis of the 5th vertebra. The *longissimus cervicis* corresponding to the 6th vertebra arises from the anterior zygapophysis of the 7th vertebra and is inserted on the posterior zygapophysis of the 5th vertebra. The muscle of the 5th vertebra arises from the anterior zygapophysis of the 6th vertebra and is inserted on the posterior zygapophysis of the 4th. The muscle of the 4th vertebra arises from the anterior zygapophysis of the 5th vertebra and after its origin gives out two small muscle slips one after the other. The first slip is inserted on the posterior zygapophysis of the 3rd vertebra along with the *semispinalis* corresponding to the 4th vertebra. The second slip of the muscle inserts on the posterior zygapophysis of the 2nd vertebra along with the *semispinalis* corresponding to the 3rd vertebra. The main muscle runs further forward and inserts on the lateral projection of the neural arch of the first vertebra. The splitting of the *longissimus cervicis* and its merging with the *semispinalis* muscle is somewhat similar to the pattern of the *longissimus cervicis* in *Lissemys*. As a result of such complicated arrangements of the muscle the possibility of intervertebral movements in these two long-necked turtles is much greater than that seen in *Testudo* where the neck is comparatively short. On contraction, the *longissimus cervicis* muscles bring about the lateral flexion of the neck and to a certain extent lateral rotation

also. In *Chelodina,* since the lateral flexion is the most prominent movement of the neck, the presence of the split *longissimus* at the level of the 4th cervical and its varied insertion helps in flexing the anterior half of the neck to a greater extent. The posterior half of the neck is flexed by the contraction of the *longissimus thoracis* (= *testocervicalis lateralis* of Vallois) and since these muscles are powerful the elements of *longissimus cervicis* at the level of the 7th, 6th and 5th cervical vertebrae are not so well developed as their equivalents in the first half of the neck.

The *longissimus thoracis* corresponding to the 1st thoracic vertebra in *Deirochelys* (Figs. 2, 5, L.Th.) arises from the costal plate adjacent to the 1st thoracic vertebra. The muscle gains its insertion by two heads. The median fibres join with the *longissimus cervicis* of the 8th vertebra and gain a common insertion on the posterior zygapophysis of the 7th cervical vertebra while the lateral fibres are inserted on the anterior half of the neural spine of the 6th cervical vertebra.

The *obliquus capitis* in *Deirochelys* (Figs. 1, 2, O.C.) is more developed than the one in *Chelodina* (Fig. 7). In *Deirochelys* it arises from the neural spines of the 1st and 2nd cervical vertebrae, while in *Chelodina* it arises from the neural spine of the 1st and only the anterior half of the neural spine of the 2nd cervical vertebra. In both cases the muscle runs obliquely forward and outward to gain insertion on the inner lower border of the squamosal and the posterior border of the opisthotic and prootic bones. In *Lissemys,* the *obliquus capitis* is in two parts, a superficial and a deeper one (George and Shah, 1954). In *Testudo,* as in *Deirochelys* and *Chelodina,* it has only one part. The muscle in all these animals acts as a lateral rotator of the head.

In *Lissemys* and in *Testudo* there is a set of *rectus capitis* muscles consisting of two parts, viz., the *rectus capitis superficialis* and the *rectus capitis profundus.* In *Chelodina* there is only one muscle and this corresponds to the *rectus capitis profundus* of *Lissemys.* In *Deirochelys* there are two muscles as in *Lissemys* and *Testudo.* It may be that all the cryptodires have two *rectus capitis* muscles while all the pleurodires have only one; this, however, will have to be confirmed by examining more forms. The *rectus capitis profundus* in *Chelodina* (Fig. 7, R.C.P.) arises from the lateral projection of the neural arch of the 1st vertebra and is inserted on the basioccipital and the prootic

bones. In *Deirochelys* (Fig. 2) the muscle has similar patterns of origin, course and insertion as described for *Chelodina*. The *rectus capitis superficialis* in *Deirochelys* (Fig. 2, R.C.S.) arises from the neural spine of the first vertebra just alongside the place of origin of the *obliquus capitis* muscle. The muscle runs anteriorly toward the base of the skull and is inserted on the posterior border of the prootic and the basioccipital. The *rectus capitis superficialis* and the *rectus capitis profundus* aid the *obliquus capitis* in bringing about the lateral flexion and the rotation of the head.

The *rectus capitis cervico-plastralis* (= *capitis plastralis* of Edgeworth, 1935, and the *sternomastoid* of Owen, 1866) in *Deirochelys* (Figs. 1, 3, R.C.C.P.) is a very slender muscle which arises from the epiplastral plate and runs laterally the entire length of the neck and finally inserts on the base of the skull. This muscle acts as a retractor of the head and neck and also helps in ventral flexion of the head. In *Chelodina* this muscle is absent.

The *rectus cervicis* in *Chelodina* (Fig. 6, R.C.) arises from the middle of the dorsal surface of the coracoid bone, while in *Deirochelys* (Figs. 1, 3) it arises from the distal end of the dorsal surface of the coracoid as in *Lissemys* and *Testudo*. This shift of the place of origin of the muscle in *Chelodina* is probably due to the overlapping of the distal ends of the coracoid of either side. The muscle in *Chelodina* after its origin runs toward the hyoid apparatus. In the middle of the neck the muscle joins with the inner side of the *constrictor hyoideus* of its side and runs forward with this as a single flat muscle. On approaching the posterior cornu, the two muscles separate. The *rectus cervicis* during its course remains closely adherent to the ventral side of the oesophagus. The lateral fibres of the muscle, after it has separated from the *constrictor hyoideus*, insert on the posterior and the ventral border of the proximal end of the posterior cornu while the rest of the fibres run beyond the posterior cornu and insert on the lateral side of the basihyal. There is a thin tendinous interval in the middle of the length of the muscle. The *rectus cervicis* in *Deirochelys* differs slightly from that of the *Chelodina* in being more massive, and in its place of insertion. The muscle in *Deirochelys* after its origin runs along the neck and has a distinct tendinous interval. After the tendinous interval some of the dorsal fibres insert directly on the ventral side of the oesophagus wall and the rest of the

muscle runs over the anterior cornu and inserts on the lateral side of the basihyal. The muscle in *Testudo* shows a pattern in its course and insertion similar to that in *Deirochelys* but in *Lissemys* the muscle is greatly modified by a split into three parts which have separate insertions (George and Shah, 1954, 1955). Comparison shows that the part of the muscle in *Lissemys* which inserts on the ventral wall of the oesophagus is similar to the fibres of the muscle in *Deirochelys* which are directly inserted on the oesophagus, while the other two parts of the muscle in *Lissemys* are comparable with the rest of the muscle in *Deirochelys*. In *Chelodina* the muscle does not attach by any fibre to the oesophagus but is only in close contact with it. The absence of the fibres inserting on the oesophagus in *Chelodina* may be explained when we notice that there is no need to have any pull exerted on the oesophagus, as is necessary in the cryptodires where the neck is pulled under the shell. The primary action of the *rectus cervicis* is to bring about movements of the hyoid, but when acting in combination with the other retractor muscles of the head and neck it is also a retractor of the head and the neck.

The *retrahens capitis collique* is the longest and the most powerful of the retractors of the head and neck in all the cryptodire chelonians. In *Deirochelys* (Figs. 1, 3, R.C.C.) it arises from the centra of the 8th and 9th thoracic vertebrae. After the origin of the muscle a small slip of muscle from each side crosses over to the opposite side and merges with the main muscle of that side. This crossing of the muscle slips is seen only when the muscles of either side are pulled apart at their bases. The muscle runs anteriorly and passes into the neck where it continues to the base of the skull. At the level of the third cervical vertebra it gives out a small muscle slip which gains insertion on the diapophysis of the second vertebra by a thin tendon. The rest of the muscle is inserted on the basioccipital and the posterior border of the opisthotic bone by a thick flat tendon. The *retrahens capitis collique* in *Chelodina* is very different. In *Chelodina* (Figs. 6, 7, 8) the muscle consists of four distinct fascicles. The longest fascicle (*fasciculus No. 1*) is also the most massive. It arises from the neural plate which covers the 5th and 6th thoracic vertebrae. It runs anteriorly into the neck and on its way toward the base of the skull it gives out four muscle slips, one after the other. These four muscle slips are inserted, one each on the diapophysis of the 4th,

3rd, 2nd and 1st cervical vertebrae. Just before their insertion they become tendinous and receive on their median side the *longus colli* muscles corresponding to the 4th, 3rd, 2nd and 1st cervical vertebrae, respectively. Thus the *longus colli* muscles (Ln.C.) and the four muscle slips of the *no. 1 fasciculus* have common insertions. The main part of the *no. 1 fasciculus* of the *retrahens capitis collique* gains its insertion on the basioccipital by a thick tendon. The next fascicle (*fasciculus no. 2*) of the *retrahens capitis collique* arises from the neural plate which covers the 5th thoracic vertebra and runs anteriorly parallel to the first. At the level of the 8th cervical vertebra the fibres of this fascicle decussate with those of the part of the *scalenus* muscle which has its origin from the anterior border of the proximal half of the scapula. After decussation the conjoined muscle becomes tendinous and before it gains its insertion on the diapophysis of the 6th cervical vertebra it receives the *longus colli* muscles corresponding to the 8th and the 7th cervical vertebrae. *Fasciculus no. 3* of the *retrahens capitis collique* arises from the neural plate covering the 4th thoracic vertebra and also from the lateral side of its centrum. It runs parallel to the first two fascicles and enters the neck. The dorsal fibres of the third fascicle become tendinous and form a thin plate on which the ventral fibres insert, and finally the tendinous plate narrows down into a slender tendon which inserts on the diapophysis of the 7th cervical vertebra. The last, *no. 4 fasciculus* of the muscle, is the shortest. It arises from the neural plate which covers the 3rd thoracic vertebra and runs forward into the neck to insert on the diapophysis of the 8th cervical vertebra by a thin tendon.

In *Lissemys, Trionyx* and *Geoemyda* the muscle has a multiheaded origin but all the heads finally merge with one another and form a single muscle belly which runs anteriorly to insert on the base of the skull. The muscle in *Deirochelys,* as described above, differs primarily in that it arises by only one head. These four genera, in which the muscle even if arising by a number of heads becomes one single belly, can be grouped together. Another group includes *Testudo* and *Emys europea*[1] (Owen, 1866) where the muscle arises by a number of heads and the several parts remain separate and have separate insertions. Pleurodires, e.g. *Chelodina,* form a third group: the *retrahens capitis collique* arises by a number of heads and, as in the second group,

[1] = *E. orbicularis*

the parts remain separate but the disposition of the muscles is lateral rather than ventral. In addition, the muscle shows further splitting and still more separate insertions; as a result of this pattern, all the vertebrae in the cervical region receive a fascicle or a part of a fascicle and so the lateral flexion of the neck becomes very effective.

In the cryptodires this muscle is the main retractor of the head and neck under the shell when the muscles of both sides act simultaneously but when the muscle of only one side acts, the head and neck are laterally flexed to a limited extent. In the pleurodires, whenever the muscle of one side contracts, it acts as a powerful lateral flexor of the head and neck. Furthermore, since in *Chelodina* the *longus colli* muscles join with the fascicles of the *retrahens capitis collique*, a complex but highly efficient lateral flexor system of muscle is formed. Such a complex system is not found within any cryptodire studied so far. This may be because there is no need for a strong lateral flexor system, since the principal movement of the neck in cryptodires is the retraction and the protraction of the head and neck, and not the lateral flexion as is the case in the pleurodires.

The *longus colli* forms the ventralmost layer of the muscles in the neck region. In *Chelodina* (Fig. 8, Ln.C.) this set of muscles is very simple and shows segmental arrangement. The muscle corresponding to the 8th cervical vertebra arises from the midventral line of the centrum of the same vertebra and the fibres are inserted on the posterior half of the tendon of the *no. 2 fasciculus* of the *retrahens capitis collique* muscle of the same side. The *longus colli* corresponding to the 7th cervical vertebra arises from the midventral line of the centrum of the same vertebra and is inserted on the anterior half of the tendon of the *no. 2 fasciculus* of the *retrahens capitis collique* which finally, after receiving the *longus colli* of the 7th and 8th cervical vertebrae, inserts on the diapophysis of the 6th vertebra. As described above, the *longus colli* muscles corresponding to the 5th, 4th, 3rd, 2nd and 1st cervical vertebrae arise from the midventral line of the centrum of their corresponding vertebrae and insert on the tendons of the remaining fascicles of the *retrahens capitis collique* muscle to gain a common insertion.

The *longus colli* in *Deirochelys* (Fig. 4, Ln.C.) is more complex than that found in *Chelodina*. In *Deirochelys* the muscle of each side combines with the *intertransversarii colli* of its own side. The muscle corresponding to the 8th cervical vertebra arises from the midventral line of the centrum of the same

vertebra by two heads which after their separate origin join with each other at the level of the posterior end of the 7th vertebra. The combined muscle belly runs forward toward the

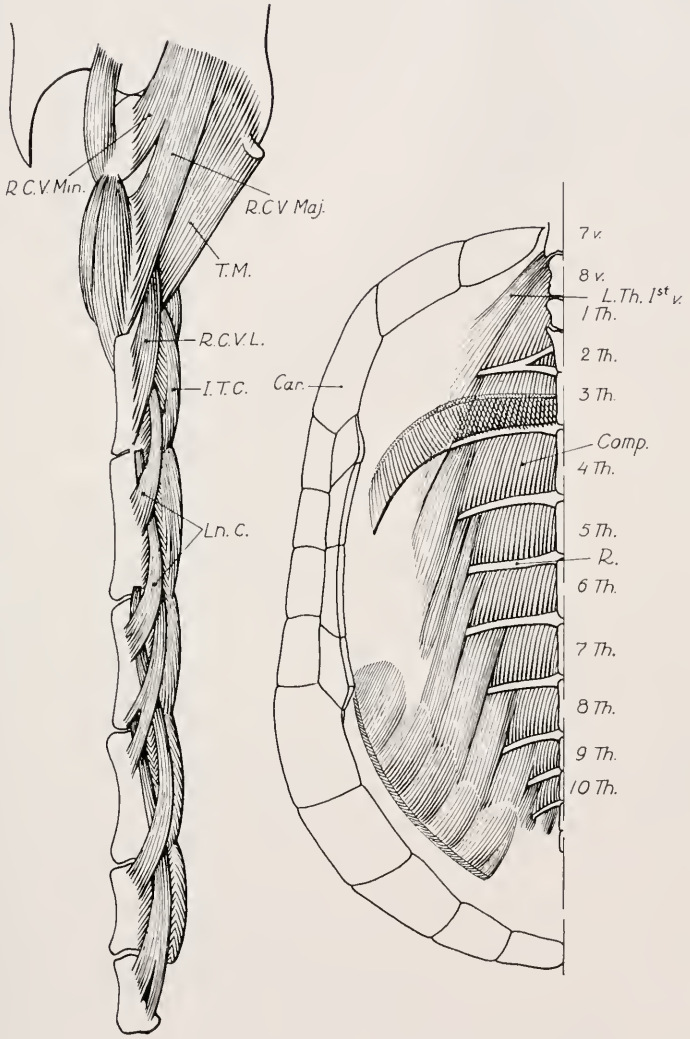


Fig. 4. *Left.* Ventral view of the head and neck of *Deirochelys* showing deeper layer of ventral muscles after removing all the superficial muscles.

Fig. 5. *Right.* Ventral view of the carapace of *Deirochelys* showing the main vertebral muscles.

posterior end of the 5th vertebra. On its way it receives the median fibres of the *intertransversarii colli* corresponding to the 7th and 6th cervical vertebrae and finally gains a common insertion on the posterior end of the centrum of the 5th vertebra by a thick tendon. The muscle corresponding to the 7th vertebra arises from the anterior part of the midventral line of the centrum of the 7th vertebra which has a ridge-like projection. The muscle runs anteriorly and passes alongside the 6th vertebra and at the level of the posterior end of the 5th vertebra becomes tendinous and inserts just anterior to the place of insertion of the *longus colli* of the 8th vertebra. Before it gains its insertion the muscle receives median fibres of the *intertransversarii colli* corresponding to the 6th vertebra. Similar is the pattern of origin, course and insertion of the *longus colli* muscles corresponding to the 6th, 5th and 4th vertebrae, except for a slight modification in the insertion of the muscles of the 6th and 5th vertebrae which merge with each other and gain a common insertion on the posterior end of the centrum of the 3rd vertebra. The muscle corresponding to the 4th vertebra gains its insertion on the centrum of the 2nd vertebra.

The *longus colli* muscles corresponding to the first three cervical vertebrae arise from the midventral line of the entire length of the centra of these vertebrae. The fibres of the muscle corresponding to the 3rd vertebra run forward and at the level of the 2nd vertebra form a flat tendon which gains its insertion on the base of the skull on the ventral side. This muscle, since it inserts on the skull, is known as the *rectus capitis ventralis longus* (Fig. 4, R.C.V.L.). It corresponds to the similar muscle in *Lissemys* which, however, does not become tendinous. The muscles of the 2nd and 1st vertebrae correspond to the *rectus capitis ventralis major* (Fig. 4, R.C.V.Maj.) and the *rectus capitis ventralis minor* (Fig. 4, R.C.V.Min.) of *Lissemys,* respectively. These two muscles merge with the tendinous part of the *rectus capitis ventralis longus* and gain a common insertion. In *Chelodina* (Fig. 8) also, the *longus colli* of the first three vertebrae are well developed and are similarly named. The only difference is that the *rectus capitis ventralis longus* does not become tendinous as in *Deirochelys.* These *rectus capitis ventralis* muscles act as the lateral rotator and the lateral flexor of the head in both genera.

The *trachelomastoideus* is also a ventral occipital muscle. In *Deirochelys* (Fig. 4, T.M.) it has a broad tendinous origin from

the ventral side of the centra of the 1st and 2nd cervical vertebrae. After origin the fibres run obliquely outward and forward toward the inner border of the squamosal and the prootic bones, where they insert. The muscle in *Chelodina* (Fig. 8) has a different origin from that in *Deirochelys*. It arises from the tendons of the first three muscle slips of the *no. 1 fasciculus* of the *retrahens capitis collique* muscle. The fibres after their origin join with each other to form a single flat muscle which runs obliquely outward and inserts on the posterior border of the prootic and the posterior end of the squamosal bone. The *trachelomastoideus* in all the cryptodires studied, viz. *Lissemys*, *Testudo* (George and Shah, 1955) *Emys orbicularis* (Owen, 1866) and the *Deirochelys*, has its origin from the ventral side of the centra of the 1st and 2nd cervical vertebrae but in *Chelodina* (a pleurodire) the muscle arises from the tendons of the *retrahens capitis collique* — a mechanical modification that is very effective in bringing about the lateral flexion of the head whenever the neck is being flexed laterally.

The *intertransversarii colli* in *Deirochelys* (Fig. 4, I.T.C.) is a segmentally arranged set of muscles. The muscle corresponding to the 7th cervical vertebra arises by two heads, a lateral and a median. The former arises from the diapophysis of the 7th vertebra and the latter arises from the ventro-lateral border of the centrum of the same vertebra. A few fibres of the median head of the *intertransversarii* decussate with fibres of the *longus colli* muscle corresponding to the 8th cervical vertebra, while the rest of the fibres of the median head join with the fibres of the lateral head and gain a common tendinous insertion on the posterior end of the diapophysis of the 6th vertebra. The muscles of the 6th, 5th, 4th and 3rd show similar arrangement of their origin, course and insertion, while that of the 2nd vertebra after its origin, instead of being inserted on the 1st vertebra gains its insertion on the odontoid process. In *Chelodina* the muscle is very simple and shows a segmental arrangement very similar to that found in *Lissemys*. The following is the pattern of origin, course and insertion of a typical set of the *intertransversarii colli* muscles in *Chelodina*. The muscle corresponding to the 8th cervical vertebra arises by two heads, the lateral and the median. The former arises from the diapophysis of the 8th vertebra while the latter arises from the midventral line of the centrum of the same vertebra. The fibres of both heads decussate and form a single muscle which is inserted on the

posterior end of the centrum of the 7th vertebra. The muscles corresponding to the 7th, 6th, 5th, 4th, 3rd, 2nd and 1st cervical vertebrae show this arrangement of origin, course and insertion,

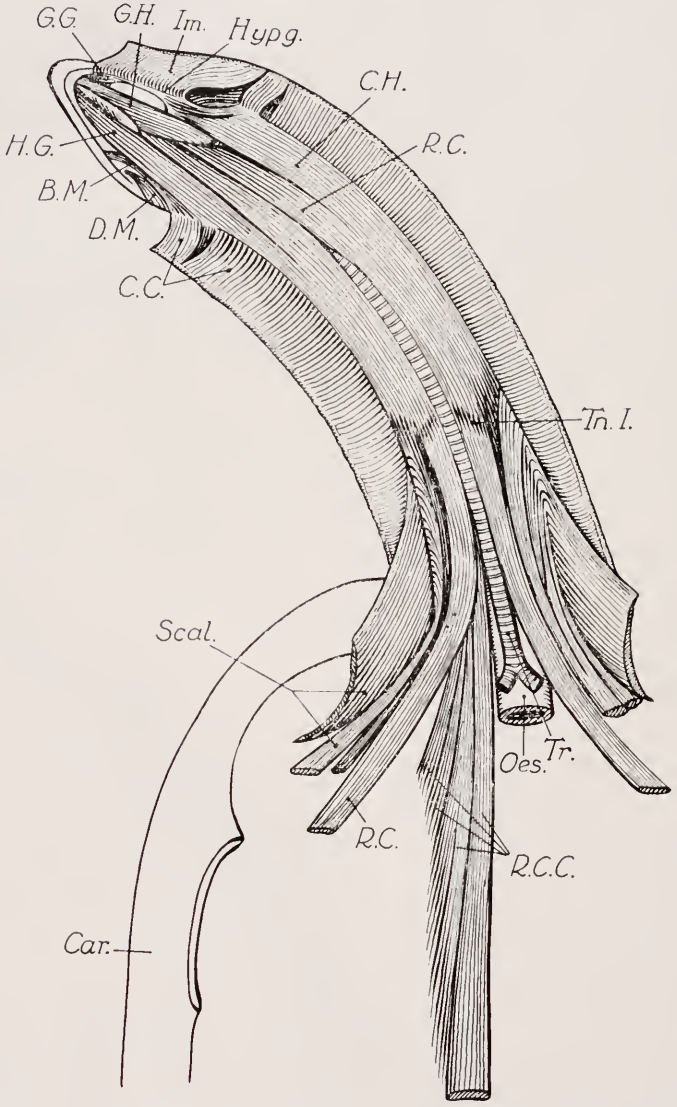


Fig. 6. Ventral view of the head, neck and anterior part of carapace of *Chelodina* showing the superficial muscles.

except for the muscle corresponding to the 1st vertebra which inserts on the basioccipital.

The *intertransversarii colli* of *Deirochelys* (Fig. 8, I.T.C.) differs from that of *Chelodina* in merging with the *longus colli* muscle of the same side. Such a merging does not take place in *Chelodina*. In *Lissemys* and *Testudo* also there is no such merging, so it appears that the condition present in *Deirochelys* is peculiar to the genus or perhaps to the subfamily.

The *intertransversarii colli obliqui* is a set of muscles dorsal to the *intertransversarii colli* in *Chelodina* (Fig. 7, I.T.C.O.), much as in *Lissemys*. This set of muscles is absent in *Deirochelys* and *Testudo*. In *Chelodina* as in *Lissemys* the muscle shows segmental arrangement. There is no muscle corresponding to the 8th cervical vertebra in *Chelodina*. The one corresponding to the 7th vertebra arises from the anterior border of the diapophysis of the same vertebra and after running forward is inserted on the posterior diapophysis of the 6th vertebra. The muscles corresponding to the 6th, 5th, 4th, 3rd, 2nd and 1st cervical vertebrae show similar patterns of origin, course and insertion, except for the muscle corresponding to the 1st vertebra which gains its insertion on the base of the skull at the posterior border of the otic capsule. The muscles of each of the first three cervical vertebrae have an extra slip separate from the main muscle. All three slips join and form an extra muscle bundle which is not seen in *Deirochelys* or in *Lissemys*. This muscle bundle inserts next to the *intertransversarii colli obliqui* of the 1st vertebra. This high modification of the *intertransversarii colli obliqui* in *Chelodina* is correlated with the importance in this genus of lateral flexion of head and neck and aids the action of the main lateral flexors of the head and neck.

In *Chelodina* there is an additional muscle which arises from the undersurface of the 1st costal plate. There are two muscle fascicles at the point of origin but after a short distance they merge to form a single belly. This muscle anteriorly becomes tendinous and the tendon runs forward to the base of the skull where it inserts on the posterior border of the prootic bone. This muscle is not present in any of the cryptodires studied (i.e. *Deirochelys*, *Lissemys* and *Testudo*). Vallois (1922) has described such a muscle as the *testocapitis* (Figs. 7, 8, T.C.) — one of the principal lateral flexors of the head and neck in pleurodires.

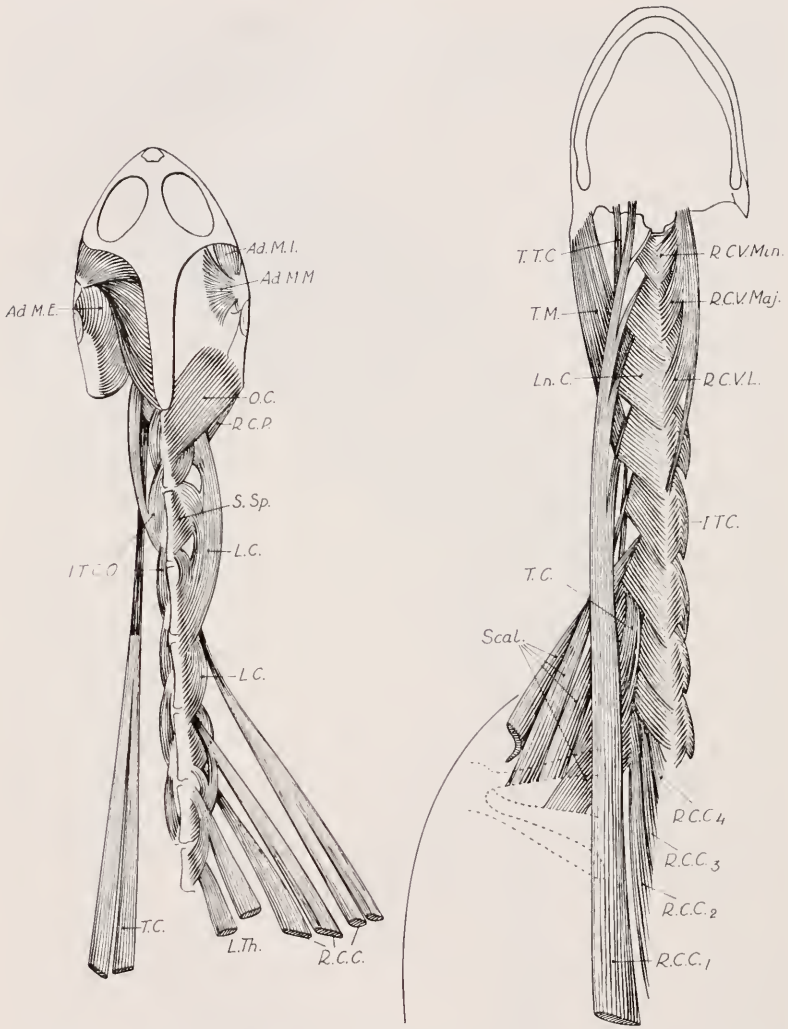


Fig. 7. *Left.* Dorsal view of the head and neck of *Chelodina* showing epaxial muscles. *Testocapitis* of one side and the *retrahens capitis collique* and *longissimus thoracis* of the other side are shown.

Fig. 8. *Right.* Ventral view of the head, neck and anterior half of the carapace of *Chelodina* showing deeper layer of muscles and particularly the *retrahens capitis collique.*

The *scalenus* in *Chelodina* (Figs. 6, 8, Scal.) is highly developed. It arises by four different heads and each one inserts separately. The first part of the muscle arises from the anterior border of the distal half of the scapula. The muscle fibres run toward the base of the neck where they decussate with the fibres of the second fasciele of the *retrahens capitis collique* muscle of its side. Finally, there is a common insertion along with the *retrahens capitis collique* muscle (see above for full description). The second part of the *scalenus* arises from the posterior border of the proximal half of the clavicular part of the scapula, while the third part of the muscle arises from the clavicular part of the scapula just adjacent to the place of origin of the second part and towards the distal end of the bone. Both these muscles run parallel to one another anteriorly into the neck and after a short distance become tendinous to gain insertion on the diapophysis of the 5th and 4th cervical vertebrae, respectively. As described above, they receive the *longus colli* muscles of the 6th and 5th cervical vertebrae before their insertion. The fourth and last part of the *scalenus* is very flat and arises from the posterior border of the distal end of the clavicular part of the scapula. After its origin the muscle runs toward the lateral side of the neck where on reaching the vertebral column it inserts on the lateral side of the neural arches of the 7th, 6th and the posterior half of the 5th cervical vertebrae. When these *scaleni* muscles of both sides act together the neck is kept extended anteriorly, but when a set of one side only contracts the posterior half of the neck is pulled under the side of the shell, thus acting as the lateral flexors of the neck. Such extensive *scalenus* muscles are practically absent in all the cryptodires studied (*Deirochelys*, *Lissemys* and *Testudo*).

The *spinalis*, *semispinalis* and the *longissimus dorsi* in the trunk region of most chelonians are very poorly developed since the trunk vertebrae have lost their intervertebral movements. But, nevertheless, the remnants of these muscles are present in most turtles. In *Deirochelys* (Fig. 5, Comp.) these muscles in the trunk region are exceptionally well developed even though the intervertebral movements are not possible. These muscles also show some kind of segmental pattern as far as the origin is concerned, but the insertion is a common one. The muscle group corresponding to the 10th trunk vertebra arises from the costal plate and the neural plate which covers this vertebra and also from the anterior and the ventral surfaces of the free

part of the 10th rib. All the fibres, after their origin, run forward passing through the space between the carapace and the ribs and emerge at the anterior end of the 1st trunk vertebra. Similarly, muscle groups of all the first nine trunk vertebrae originate, run forward and emerge in the same way between the first rib and the carapace. All these ten muscle groups gain a common tendinous insertion on the diapophysis and the lateral side of the neural arch of the 8th cervical vertebra. This highly developed group of trunk vertebral muscles, when contracted, extends the neck and brings about the protraction of the head and neck. Such an extensive trunk vertebral muscular system is also present in *Emys blandingii* but absent in both *Lissemys* and *Testudo*.

MOVEMENTS OF THE HEAD AND NECK

Among the cryptodires, the principal neck movement is the protraction and retraction of the head and neck, though extent of retraction in this suborder varies greatly. *Deirochelys* and *Lissemys* represent those cryptodires which can retract their head and neck fully under the shell, while the marine forms, viz. *Eretmochelys*, *Chelonia* and *Caretta* represent those which can only partially retract their neck under the shell. *Chelodina* is a representative of the pleurodires which bend their head and neck under the side of the shell. True retraction of the head and neck in pleurodires is not possible. The other movements of the head and neck in both cryptodires and pleurodires are similar. When the head and neck are in the protracted state in the cryptodires, or when these parts are extended in pleurodires, the flexion and lateral rotation, extension or elevation, and the lateral rotation and partial lateral flexion of the head and neck are observed.

The principal lateral flexors of the head and neck in *Chelodina* are the *testocapitis*, *retrahens capitis collique*, *rectus cervicis*, *rectus capitis cervico-plastralis* and the highly modified hypaxial and epaxial muscles of the cervical vertebrae. The lateral flexion of the neck is brought about by the combined action of all these muscles of one side. The protraction of the head and neck in *Deirochelys* is brought about by the contraction of the following muscles of the two sides acting simultaneously: *retrahens capitis collique*, *rectus cervicis*, *rectus capitis cervico-plastralis*.

A detailed description of the other individual movements of the head and neck in *Lissemys* is given by George and Shah

(1954); since this holds good for these movements in *Deirochelys* and *Chelodina* they are not repeated here.

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ABBREVIATIONS

Ad.M.E.	Adductor mandibulae externus
Ad.M.I.	Adductor mandibulae internus
Ad.M.M.	Adductor mandibulae medius
B.M.	Branchiomandibularis
Car.	Carapace
C.C.	Constrictor colli
C.H.	Constrictor hyoideus
Comp.	Complex muscle formed by union of longissimus thoracis, spinalis and semispinalis
D.M.	Depressor mandibulae
G.G.	Genioglossus
G.H.	Geniohyoideus
Hypg.	Hypoglossum (Entoglossum)
H.G.	Hyoglossus
Im.	Intermandibularis
I.T.C.	Intertransversarii colli
I.T.C.O.	Intertransversarii colli obliqui

L.C.	Longissimus cervicis
L.C.$_1$	Lateral part of longissimus cervici
L.Th.	Longissimus thoracis
Ln.C.	Longus colli
Oes.	Oesophagus
O.C.	Obliquus capitis
R.	Rib
R.C.	Rectus cervicis
R.C.C.	Retrahens capitis collique
R.C.C.$_1$	1, 2, 3, and 4 parts of Retrahens capitis collique
R.C.C.$_2$	
R.C.C.$_3$	
R.C.C.$_4$	
R.C.C.P.	Rectus capitis cervico-plastralis
R.C.P.	Rectus capitis profundus
R.C.S.	Rectus capitis superficialis
R.C.V.L.	Rectus capitis ventralis longus
R.C.V.Maj.	Rectus capitis ventralis major
R.C.V.Min.	Rectus capitis ventralis minor
Scal.	Scalenus
S.C.C.	Spinalis cervico-capitis
Sp.	Semispinalis muscles attaching to nuchal plate
S.Sp.	Part of the semispinalis system
T.C.	Testocapitis
Th.	Thoracic vertebra
T.M.	Trachelomastoideus
Tn.I.	Tendinous interval
Tr.	Trachea
T.T.C.	Tendon of the testocapitis
7v.	Seventh cervical vertebra
8v.	Eighth cervical vertebra

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CATALOGUE OF TYPE SPECIMENS IN THE INVERTEBRATE PALEONTOLOGICAL COLLECTIONS OF THE MUSEUM OF COMPARATIVE ZOOLOGY ARTHROPODA

(Trilobita, Arachnida and Insecta excluded)

By W. D. Ian Rolfe

With One Plate

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CATALOGUE OF TYPE SPECIMENS IN THE INVERTEBRATE PALEONTOLOGICAL COLLECTIONS OF THE MUSEUM OF COMPARATIVE ZOOLOGY

ARTHROPODA

(Trilobita, Arachnida and Insecta excluded)

BY W. D. IAN ROLFE

WITH ONE PLATE

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No. 7 — *Catalogue of Type Specimens in the Invertebrate Paleontological Collections of the Museum of Comparative Zoology Arthropoda (Trilobita, Arachnida and Insecta excluded)*

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PREFACE

The award in 1958 by the National Science Foundation of a facilities grant to the Museum of Comparative Zoology has made possible great improvements in the housing and cataloguing of the collections of fossil invertebrates. Dr. W. D. Ian Rolfe came to the Museum in 1961, and has spent more than a year in curatorial work on parts of the arthropod collections. A most welcome outcome of his work is this catalogue, which is the first to be prepared for publication on any of the fossil invertebrate groups in the Museum. Excluded from it are Trilobita, the largest part of the arthropod collections, for which a separate catalogue is in preparation. Fossil arachnids and insects are in the care of the curators of Arachnology and Fossil Insects, respectively, and are therefore omitted. Few specimens in the groups studied by Dr. Rolfe had previously been catalogued, and it is hardly surprising that his work reveals the whereabouts of a number of long-lost and important types. It is hoped that this catalogue may be the first of a series which will make known more widely and clearly the importance of the Museum's collections of fossil invertebrates.

H. B. Whittington,
Curator of Invertebrate Paleontology

INTRODUCTION

A general survey of the contents of the invertebrate paleontological collections in the Museum of Comparative Zoology was prepared by P. E. Raymond (1936) for the Tercentennial of the Founding of Harvard College. Details of accessions are published in the Annual Reports of the Director of the Museum. The extra-New England type specimens obtained by exchange with the Boston Society of Natural History between 1914 and 1934 are also given in Cushman's catalogue (1907). Accession lists of specimens originally in the Boston Society's museum can be found listed under "Donations to the Cabinet" and in the curators' annual reports in volume 1 of the Boston Journal of Natural History (1837), volumes 36 and 38 of the American Journal of Science (1839, 1840), and subsequently in the Proceedings of the Boston Society of Natural History. The Eser Collection, secured "by a lucky accident" (Hyatt, 1874, p. 4) for the Boston Society in 1873, was catalogued by Reuss (1850). This publication is rare, however, and although most of the specimens listed are not otherwise mentioned in the literature they will be indexed here for convenience. The "Catalogue des fossiles du Système Silurien du Centre de la Bohême de la collection du défunt J. M. von Schary à Prague," published by Rohlíček and Sievers at Prague (no date), lists 645 specimens under 58 species of non-trilobite arthropods (p. 14). This collection was purchased for the Museum by Alexander Agassiz in 1882; entries in that catalogue are not indexed here, however.

Explanation of entries. Genera and species are listed alphabetically under genus within the suprageneric groups listed in the Contents. Entries are made under the most up-to-date combination of specific and generic names known to the writer but previous combinations *used in referring to the specimen* are given as cross-references. Thus, complete synonymies are not attempted. Abbreviations, terminology, and usage are those established by R. C. Moore in the Editorial Preface to volumes of the "Treatise on Invertebrate Paleontology."

Citation of authors following the binomen on the first line of each entry follows Recommendation 51B of the 1961 International Code of Zoological Nomenclature. If a specimen is the holotype, or specimens are the syntypes, of the type species of a genus, this is indicated by OD if by original designation, or by SD if by subsequent designation. The author and page number for the subsequent designation are also given.

The second line gives the geological horizon and locality, with the style as on pages xviii to xxiii of Treatise volumes I and Q.

Subsequent lines indicate whether the specimen is a holotype, paratype, syntype, lectotype or paralectotype, by obvious abbreviations. In addition, "hypotype" material has been differentiated into FIGD, if referred to and figured, or REFD, if only referred to in the literature. If a figured specimen was referred to prior to the publication in which it was first figured, such references are given after the reference containing the figure. Different references to the same specimen are separated by semicolons and the name of the author is omitted if the same as in the preceding reference. The Museum of Comparative Zoology Arthropod Catalogue number is separated from the last reference to the specimen by an equal sign. Numbers which follow an oblique stroke indicate different specimens having the same catalogue number. Letters a, b and a/b following the number indicate that the specimen comprises part and counterpart. The name of the collector is given, where known, following the last specimen collected by him within each entry, and preceded by *Coll.*

The opportunity is taken to list arthropods to be figured by the writer in Treatise volume R, since there is no provision in that work for reference to specimen numbers and repositories.

Acknowledgment. The writer is greatly indebted to Professor H. B. Whittington for giving him the opportunity to curate these collections and for much valuable advice and help.

TRILOBITOIDEA

Houghtonites gracilis (Walcott) Raymond

Burgess Sh., M. Cam.; Field, B. C.

FIGD: Raymond, 1931, p. 200-203, pl. 4 fig. 6; 1926, p. 21 = **1811a**. *Coll.* J. D. Houghton. *N.B.* The holotype of the type species is USNM 57661, not MCZ 1811a/b as incorrectly designated by Raymond, 1931, p. 203.

Leanchoilia superlata Walcott

Burgess Sh., M. Cam.; Field, B. C.

FIGD: Raymond, 1935, p. 206-208, 211, 214, fig. 1 = **1843.** P. 206, 209-211, fig. 2 = **1846b**.

REFD: Raymond, 1935, p. 205, 208, 209-213 = **1842, 1844, 1845.** P. 212 ("Another isolated telson . . .") = **4469.** P. 212 ("The telson of still another") = **5965**/2. *Coll.* C. H. Burgess, P. E. Raymond, W. E. Schevill and H. C. Stetson.

Mollisonia gracilis Walcott
See *Houghtonites gracilis*

Sidneyia groenlandica Cleaves *in* Cleaves and Fox
Ymer F., ?M. Cam.; Ymer I., E. Greenland
HOLO: Cleaves and Fox, 1935, p. 485, pl. 42 fig. 1 = **3225.** *Coll.* A. B. Cleaves.
Eha (1953, p. 15-16) has suggested that this specimen is a ripple mark and not a fossil.

XIPHOSURA

Anacontium breve Raymond
Wellington F., L. Perm.; Noble Co., Okla.
HOLO: Raymond, 1944, p. 497, fig. 6 = **4726**a. *Coll.* F. M. Carpenter.

Anacontium carpenteri Raymond OD p. 496
Wellington F., L. Perm.; Noble Co., Okla.
HOLO: Raymond, 1944, p. 496, fig. 5 = **4724**a. *Coll.* F. M. Carpenter.
PARA: Raymond, 1944, p. 496 = **4725**a/b. *Coll.* F. M. Carpenter.

Bellinurus danai Meek and Worthen
See *Euproops danai.*

Euproops danai (Meek and Worthen) Meek
Carbondale F., M. Penn.; Mazon Creek, Ill.
REFD: Raymond, 1944, p. 486 = **4673.** *Coll.* F. Thompson. Hyatt, 1894, p. 50; Raymond, 1944, p. 486 = **4686**a/b. *Coll.* C. E. Beecher.

Euproops darrahi Raymond
Mason Sh., U. Penn.; Fair Oaks, Pa.
HOLO: Raymond, 1944, p. 489-490, pl. 2 fig. 4 = **4691.** *Coll.* W. C. Darrah.

Euproops laticephalus Raymond
Salem Coal, U. Penn.; Pottsville, Pa.
HOLO: Raymond, 1944, p. 491, fig. 4 = **4692.** *Coll.* Leo Lesquereux.

Euproops packardi Willard and Jones
"Low in Coal Measures," Penn.; Wilkes-Barre, Pa.
REFD: Raymond, 1944, p. 493 = **4693.** *Coll.* Leo Lesquereux.

Euproops thompsoni Raymond
Carbondale F., M. Penn., Wilmington Strip Mine, Ill.
HOLO: Raymond, 1944, p. 486-489, fig. 1; Raymond, 1945, p. 5 = **4669**a/b.
PARA: Raymond, 1944, p. 489 = **4670**a/b, **4676**a/b, **4682**a/b.

Coll. F. Thompson. P. 489, fig. 1; Raymond, 1945, p. 5 = **4683**a/b. Raymond, 1944, p. 489, fig. 2; Raymond, 1945, p. 5 = **4684**a. *Coll.* Ward's.

Liomesaspis laevis Raymond OD

Carbondale F., M. Penn.; Mazon Creek, Ill.

HOLO: Raymond, 1944, p. 498-501, fig. 9 = **4698.** *Coll.* Mt. Holyoke College.

PARA: Raymond, 1944, p. 498-501, fig. 7 = **4696**a. P. 501 = **4697.**

Paleolimulus avitus Dunbar

Wellington F., L. Perm.; S. E. of Elmo, Kans.

FIGD: Raymond, 1944, p. 506, pl. 1 = **4658**a. P. 505, 507, pl. 2 fig. 1 = **4660**a. Pl. 2 fig. 3 = **4661**a (misprinted "4161"). P. 507, pl. 2 fig. 2 = **4662**a.

REFD: Raymond, 1944, p. 505 = **4659.** P. 505-507 = **4664**a/b. P. 506, 507 = **4665**a/b (misprinted "6665"). P. 506 = **4667.** P. 505, 506 = **4668**a/b. *Coll.* F. M. Carpenter.

Prolimulus woodwardi Fritsch

Plate 1, figure 1.

Gaskohle, U. Carb.; Nýřany, Czech.

REFD: Raymond, 1944, p. 504 = **4694.** *Coll.* F. Krantz.

EURYPTERIDA

Adelophthalmus mansfieldi (C. E. Hall) Přibyl

Darlington Sh., M. Penn.; Cannelton, Pa.

REFD: Kjellesvig-Waering, 1948, p. 25-27 (counterpart of USNM 28358) = **5323**/27. P. 26 = **5323**/12. P. 25 = **5323**/1-11, 13-26, 28-31. *Coll.* I. F. Mansfield.

Adelophthalmus mazonensis (Meek and Worthen) Přibyl

Carbondale F., M. Penn.; Wilmington Strip Mine, Ill.

FIGD: Kjellesvig-Waering, 1948, p. 19-20 ("specimen No. 7"), pl. 5 fig. 1 = **7162**a. P. 19-20, pl. 3 fig. 3, pl. 5 fig. 2; Oyen, 1956, p. 43, 79, fig. 27 = **7162**b. *Coll.* H. Luthe.

Carbondale F., M. Penn.; Coal City, Ill.

Kjellesvig-Waering, 1948, p. 19-20, pl. 5 fig. 4 = **7163**a. P. 19-20, pl. 4, pl. 5 fig. 3; Oyen, 1956, p. 43, 80, fig. 27b = **7163**b.

Adelophthalmus sellardsi (Dunbar) Přibyl

Elmo Ls., M. Perm.; Elmo, Kans.

FIGD: Kjellesvig-Waering, 1948, p. 38-42, pl. 7 fig. 1; Raymond, 1932, p. 33; Oyen, 1956, p. 51-52, 72, fig. 20 left = **1852**a. Kjellesvig-Waering, 1948, p. 38-42, pl.

7 fig. 2, 3; Oyen, 1956, p. 51-52, 72, fig. 20 right = **1852**b. *Coll.* F. M. Carpenter.

Ctenopterus? alveolatus Shuler

Bays Ss., M. Ord.; Lyons Gap, Va.

HOLO: Shuler, 1915, p. 551-552, fig. 4 = **1520**a.

PARA: Shuler, 1915, p. 553, fig. 1 (misprinted "fig. 3") = **1519**/1. P. 553, fig. 2 = **1519**/2. P. 553, fig. 3 = **1519**/3. P. 553, fig. 5 = **1519**/4. P. 553, fig. 6 = **1519**/5. *Coll.* E. W. Shuler.

Lepidoderma mansfieldi (C. E. Hall) Kjellesvig-Waering

See *Adelophthalmus mansfieldi.*

Lepidoderma mazonense (Meek and Worthen) Kjellesvig-Waering

See *Adelophthalmus mazonensis.*

Lepidoderma sellardsi (Dunbar) Kjellesvig-Waering

See *Adelophthalmus sellardsi.*

Stylonurus (Ctenopterus?) alveolatus Shuler

See *Ctenopterus? alveolatus.*

CONCHOSTRACA

Australoleaia acutangularis (Raymond) Novojilov

See *Leaia acutangularis*

Australoleaia ashleyi (Raymond) Novojilov

See *Leaia ashleyi*

Cornia laminata (Raymond) Kobayashi

Wellington F., M. Perm.; Noble Co., Okla.

HOLO: Raymond, 1946, p. 266, pl. 3 fig. 12 (type species of *Pemphicyclus*); Tasch, 1961, p. 1121, pl. 133 fig. 10 = **4782.**

PARA: Raymond, 1946, p. 266, pl. 4 fig. 1, 2 (fig. 2, × 15 not 12); Tasch, 1961, p. 1121, pl. 133 fig. 2, 7 = **4783-4785** (slabs). *Coll.* F. M. Carpenter and G. O. Raasch.

Cyclestherioides blackstonensis (Raymond) Kobayashi

See *Rhabdostichus blackstonensis*

Cyzicus (Euestheria) multicostatus (Emmons)

U. Trias.; Midlothian, Va.

REFD: Raymond, 1946, p. 253 = **4796.** *Coll.* J. B. Woodworth.

Cyzicus (Lioestheria) brevis (Raymond)

Wellington F., M. Perm.; Noble Co., Okla.

HOLO: Raymond, 1946, p. 243-244, pl. 2 fig. 10 (× 9.7 not 13) (type species of *Pseudestheria* (*Pseudestheria*) Raymond) = **4798**.

PARA: Raymond, 1946, pl. 2 fig. 9 (×9.0 not 12) = **4790.** P. 244 = **4805.** *Coll.* F. M. Carpenter and G. O. Raasch.

Cyzicus (Lioestheria) ovatus (Lea)

U. Trias.; Phoenixville, Pa.

REFD: Raymond, 1946, p. 254 = **7451**/1-2 (slabs). *Coll.* W. B. and H. D. Rogers.

Cyzicus (Lioestheria) ovatus? (Lea)

U. Trias.; Richmond, Va.

REFD: Bulfinch, 1843, p. 149; Rogers, 1843, p. 301 (1884, p. 647) ("*Posidonomya keuperi*?"); 1854, p. 15 (1884, p. 766) ("*cf. Posidonomya bronnii*") = **7452**/1-11a/b (on slabs with *Spirorbis* sp.). *Coll.* W. B. and H. D. Rogers.

Cyzicus (Lioestheria) plicifer (Raymond)

Wellington F., M. Perm.; Noble Co., Okla.

HOLO: Raymond, 1946, p. 249, pl. 2 fig. 12 (×7.1 not 9) = **4791.** *Coll.* F. M. Carpenter and G. O. Raasch.

Wellington F., M. Perm.; Elmo, Kans.

PARA: Raymond, 1946, p. 249 = **4712**/1-3. *Coll.* F. M. Carpenter.

Cyzicus (Lioestheria) raaschi (Raymond) Tasch

Wellington F., M. Perm.; Noble Co., Okla.

HOLO: Raymond, 1946, p. 232-233, pl. 1 fig. 4 = **4781.**

PARA: Raymond, 1946, p. 233, pl. 1 fig. 5 ("one slab") = **4807**a. *Coll.* F. M. Carpenter and G. O. Raasch.

Cyzicus (Lioestheria) rugosus (Raymond)

Wellington F., M. Perm.; Noble Co., Okla.

HOLO: Raymond, 1946, p. 250, pl. 3 fig. 2 (×7.3 not 6.75) = **4806.** *Coll.* F. M. Carpenter and G. O. Raasch.

?Cyzicus sp. indet.

M. Penn.; Blackstone River, R. I.

FIGD: Haynes, 1913, p. 192, fig. 2; Raymond, 1946, p. 279 ("?scale of a fish") = **7425.**

REFD: Haynes, 1913, p. 192 ("several specimens"); Raymond, 1946, p. 279 = **7426**/1-5. *Coll.* W. P. Haynes.

Estheria sp. indet. Haynes

See *Cyzicus* sp. indet.

Euestheria multicostata (Emmons) Kobayashi

See *Cyzicus* (*Euestheria*) *multicostatus*

Hemicycloleaia acutangularis Raymond

See *Leaia acutangularis*

Hemicycloleaia ashleyi Raymond
See *Leaia ashleyi*

Hemicycloleaia haynesi Raymond
See *Leaia haynesi*

Hemicycloleaia laevis Raymond
See *Leaia laevis*

Hemicycloleaia normalis Raymond
See *Leaia normalis*

Leaia acutangularis (Raymond) Kobayashi
M. Penn.; Blackstone River, R. I.
HOLO: Raymond, 1946, p. 292, fig. 6; Novojilov, 1956, p. 69-70, fig. 56 = **4802.** *Coll.* W. P. Haynes.

Leaia ashleyi (Raymond) Kobayashi
L. Mahoning Ss., U. Penn.; Conemaugh, Pa.
HOLO: Raymond, 1946, p. 288-289, pl. 6 fig. 3 (× 5.5 not 6.67) (misprinted "4792"); type species of *Australoleaia* Novojilov, 1954 (*cf.* Novojilov, 1956); Novojilov 1956, p. 70 = **4794.** *Coll.* P. E. Raymond. Novojilov, 1954, fig. 1z is not a paratype.

? **Leaia baentschiana** Pruvost
See *Leaia haynesi*

Leaia haynesi (Raymond) Kobayashi
M. Penn.; Blackstone River, R. I.
HOLO: Haynes, 1913, p. 192, fig. 1 ("*L. tricarinata* Meek and Worthen"); Pruvost, 1914, p. 260, 272 (= off-print p. 270) ("? *L. baentschiana* Beyrich"); Raymond, 1946, p. 291, pl. 6 fig. 6 (× 4.0 not 1.67); Novojilov, 1954, p. 1243 (type species of *Siberoleaia*); 1956, p. 25-26; Tasch, 1958, p. 1103 = **4803**a.
PARA: Raymond, 1946, p. 291; not Novojilov, 1954, fig. 1m ("paratip") = **4801.**
REFD: Raymond, 1946, p. 292 = **7450**/1-2. *Coll.* W. P. Haynes.

Leaia laevis (Raymond) Kobayashi
L. Mahoning Ss., U. Penn.; Conemaugh, Pa.
HOLO: Raymond, 1946, p. 287, pl. 6 fig. 2 (× 4.30 not 1.5) (type species of *Hemicycloleaia*); Kobayashi, 1954, p. 141; Novojilov, 1956, p. 28-29, fig. 20; 1960, fig. 556 = **4795**/1.
PARA: Raymond, 1946, pl. 6 fig. 2 ("below"); not Novojilov, 1954, fig. 1p ("paratip") = **4799.** *Coll.* P. E. Raymond.

Leaia normalis (Raymond) Kobayashi
M. Penn.; Blackstone River, R. I.
HOLO: Raymond, 1946, p. 292, pl. 6 fig. 7 (×4.2 not 2); Novojilov, 1956, p. 63, fig. 49 = **4804**b. *Coll.* W. P. Haynes.

Leaia reflexa Raymond
See *Rostroleaia reflexa*

Lioestheria raaschi Raymond
See *Cyzicus* (*Lioestheria*) *raaschi*

Mimoleaia normalis (Raymond) Novojilov
See *Leaia normalis*

Monoleiolophus conemaughensis Kobayashi
See *Monoleiolophus unicostatus*

Monoleiolophus unicostatus Raymond [= *M. conemaughensis* Kobayashi (obj.)] OD
L. Mahoning Ss., U. Penn.; Conemaugh, Pa.
HOLO: Raymond, 1946, p. 262, pl. 3 fig. 11; Novojilov, 1954, p. 1241; 1956, p. 18-19, fig. 7; Tasch, 1958, p. 1099, 1102, fig. 26 = **4792.**
PARA: Raymond, 1946, p. 262 = **4793, 7453.** *Coll.* P. E. Raymond.

Palaeolimnadiopsis carpenteri Raymond OD
Wellington F., M. Perm.; Noble Co., Okla.
HOLO: Raymond, 1946, p. 271, pl. 4 fig. 8, pl. 5 fig. 2; Varentsov, 1955, p. 310-312, pl. fig. 1, 3; Novojilov, 1958, p. 100, fig. 7; Tasch, 1962, p. 820 = **4705**a.
PARA: Raymond, 1946, p. 271, pl. 4 fig. 7, pl. 5 fig. 1; Tasch, 1956, p. 1253, fig. 5; 1962, p. 820, pl. 120 fig. 5 = **4789.** Raymond, 1946, p. 271 ("smallest specimen"); Tasch, 1962, p. 820, pl. 120 fig. 6 = **4706**a. *Coll.* G. O. Raasch and F. M. Carpenter.

Pemphicyclus laminatus Raymond
See *Cornia laminata*

Posidonia keuperi Bulfinch [?*nom. null. pro P. keuperina* Hoeninghaus *in* de la Beche (*nom. nud.*)]
See *Cyzicus* (*Lioestheria*) *ovatus*?

Posidonomya keuperi? (Bulfinch) Rogers
See *Cyzicus* (*Lioestheria*) *ovatus*?

Pseudestheria blackstonensis Raymond
See *Rhabdostichus blackstonensis*

Pseudestheria brevis Raymond
See *Cyzicus* (*Lioestheria*) *brevis*

Pseudestheria multicostata (Emmons)
See *Cyzicus* (*Eucstheria*) *multicostatus*

Pseudestheria plicifera Raymond
See *Cyzicus* (*Liocstheria*) *plicifer*

Pseudestheria rugosa Raymond
See *Cyzicus* (*Liocstheria*) *rugosus*

Rhabdostichus blackstonensis (Raymond)
M. Penn.; Blackstone River, R. I.
HOLO: Raymond, 1946, p. 247, 279, pl. 3 fig. 1; Haynes, 1913, p. 192 = **4800.** *Coll.* W. P. Haynes.

Rostroleaia reflexa (Raymond) Novojilov
Wellington F., M. Perm.; Noble Co., Okla.
HOLO: Raymond, 1946, p. 286, pl. 6 fig. 1 (× 9.5 not 4); Novojilov, 1956, p. 50, 101, 126, pl. 9 fig. 2 (× 7.7 not 4) = **4711a.** *Coll.* G. O. Raaseh.

Schizodiscus antecrenulus Cleaves
Moscow F., M. Dev.; Barnett's Mill, Pa.
HOLO: Cleaves, 1935, p. 6, 8, pl. 2 fig. 5; Willard and Cleaves, 1933, p. 775 = **1982.**
PARA: Cleaves, 1935, p. 6, 8, pl. 2 fig. 6 (× 4.2 not 3), 7 (× 6.3 not 5) = **1983, 1984.** *Coll.* A. B. Cleaves.

Siberoleaia haynesi (Raymond) Novojilov
See *Leaia haynesi*

CLADOCERA

Daphnia fossilis Heyden
Plate 1, figures 2, 3.
Braunkohle, Oligo.; Rott, N. W. Ger.
SYN: Heyden, 1862, p. 62-63, pl. 10 fig. 25; Hagen, 1870, p. 21 = **6292.** *Coll.* A. Krantz.

OSTRACODA

All of Harris' 1931 and 1957 type and figured ostracods (with the exception of *Eohollina depressa* (Kay), FIGD: Harris, 1957, p. 209, pl. 7 fig. 1a, b = **4599,** ?lost) are now in the Museum collection (*cf.* Martinsson, 1960, p. 153). For economy's sake only those species for which MCZ catalogue numbers were not given in Harris, 1957 and 1960a, will be listed here, and only selected references to them given.

Anisocyamus bassleri (Harris) Martinsson
Bromide F., M. Ord.; Arbuckle Mts., Okla.

LECTO: Martinsson, 1960, p. 146, 153; Harris, 1931, p. 92 ("female"), pl. 11 fig. 2a, b, pl. 14 fig. 2a, b; Amsden, 1957, p. 23; Harris, 1960a, p. 180 ("holotype . . . 4593A") = **7441.**

PARAL: Harris, 1931, p. 92 ("male"); 1957, p. 203, pl. 6 fig. 17a, b = **4593.** Harris, 1931, pl. 11 fig. 2c; Martinsson, 1960, p. 146 = **7442.** Harris, 1931, pl. 11 fig. 2d; Martinsson, 1960, p. 146; Harris, 1960a, p. 180 ("paratype . . . 4594A") = **7443.** *Coll.* R. W. Harris.

Balticella deckeri (Harris) Harris

Bromide F., M. Ord.; Arbuckle Mts., Okla.

HOLO: Harris, 1931, p. 89, pl. 14 fig. 5a-c; 1957, p. 242, pl. 8 fig. 7a-c; Amsden, 1957, p. 22 = **7445.** *Coll.* R. W. Harris.

"Beyrichia" bella Walcott

Trenton Ls., M. Ord.; Trenton Falls, N. Y.

HOLO: Walcott, 1883, p. 7 (1884, p. 213), pl. 17 fig. 11, 11a = **6988.** *Coll.* C. D. Walcott.

Beyrichia chambersi Miller

See *Ceratopsis chambersi*

Beyrichia moodeyi Ulrich and Bassler

See *Velibeyrichia moodeyi*

Beyrichia pennsylvanica Jones

Onondaga Salt Gr., U. Sil.; Penn's Valley, Pa.

SYN: Jones, 1858a, p. 253, pl. 10 fig. 16-18; 1858b, p. 834, fig. 696a-c; Jones and Holl, 1886, p. 347, 357; Jones, 1889, p. 340, footnote; Lesley, 1889, p. 90, fig.; Cushman, 1907, p. 259 = **6975-6977** (on slab 6978). Jones, 1858a, p. 253 = **6979** (slab).

Surgent Gr., M. Sil.; Barre Forge, Pa.

Jones, 1858a, p. 252, 253 ("a few specimens . . . a smooth variety") = **6980-6982** (on slab with *Leperditia pennsylvanica* 6968). *Coll.* H. D. and W. B. Rogers.

Cavellina nebrascensis (Geinitz) Kellett

Wabaunsee Gr., U. Penn.; Nebraska City, Neb.

HOLO: Geinitz, 1866, p. 2, pl. 1 fig. 2; Meek 1872, pl. 11 fig. 2; Kellett, 1935, p. 146; Lalicker, 1935, p. 744-745, fig. 1a-c = **4418.**

FIGD: Geinitz, 1866 ("*Cythere cyclas* v. Keys."), p. 2, pl. 1 fig. 3; Meek, 1872, pl. 11 fig. 3a = **6957.** Geinitz,

1866, p. 2, pl. 1 fig. 4; Meek, 1872, p. 237, pl. 11 fig. 3b = **4417** (figured by Lalicker, 1935, p. 744-745, fig. 3a-c), **4419** or **6958**/1-2. *Coll.* Jules Marcou.

Ceratoleperditia armata (Walcott) Harris
See *Pteroleperditia armata*

Ceratopsis chambersi (Miller) Ulrich
Cincinnatian, M. Ord.; ?Cincinnati, Ohio
?SYN: Miller, 1874b, p. 234, fig. 27; 1889, p. 534, fig. 975 = **7360.** 1874b, p. 234 = **7361**/1-4 (on slab with 7360), **7365.** *Coll.* C. B. Dyer.

Cryptophyllus magnus (Harris) Levinson
Oil Creek F., M. Ord.; Arbuckle Mts., Okla.
HOLO: Harris, 1931, p. 91, pl. 5 fig. 3a, b; 1957, p. 182; Amsden, 1957, p. 9 = **7444.** *Coll.* R. W. Harris.

Cryptophyllus simpsoni (Harris) Levinson
Bromide F., M. Ord.; Arbuckle Mts., Okla.
HOLO: Harris, 1931, p. 90, pl. 11 fig. 1 a-d, pl. 14 fig. 1a, b; 1957, p. 183, pl. 5 fig. 14a, b; Amsden, 1957, p. 22 = **7447.** *Coll.* R. W. Harris.

Dicranella? byrnesi (Miller) Ulrich
Fulton Beds, U. Ord.; Cincinnati, Ohio
?HOLO: Miller, 1874a, p. 123, fig. 10; 1889, p. 552, fig. 1020 = **7366.** *Coll.* C. B. Dyer.

Dicranella macrocarinata Harris
Bromide F., M. Ord.; Arbuckle Mts., Okla.
HOLO: Harris, 1931, p. 92, pl. 14 fig. 3a, b; 1957, p. 230, pl. 7 fig. 7a, b; Amsden, 1957, p. 22 = **7448.** *Coll.* R. W. Harris.

Elpe radiata (Ulrich) Ulrich *in* Jones
See *Elpinella radiata*

Elpinella radiata (Ulrich) Přibyl and Šnajdr SD Přibyl and Šnajdr 1950, p. 128, 171 Plate 1, figure 4.
Utica Sh., M. Ord.; Cincinnati, Ohio
HOLO: Ulrich, 1879, p. 9-10, pl. 7 fig. 2, 2a, b = **6855.** *Coll.* J. Fine, H. E. Dickhaut, and E. O. Ulrich.

Entomis nodosa Burgess
See *Entomozoe nodosa*

Entomis variostriata Clarke
See *Primitia variostriata*

Entomozoe nodosa (Burgess)
Kiln Sh., U. Dev.; Pocahontas, Alberta
LECTO: Burgess, 1931, p. 200-201, fig. 1 = **4467.**

PARAL: Burgess, 1931, p. 201 ("another specimen") = ?**6959.** *Coll.* C. H. Burgess.

Eoleperditia nana? (Jones) Swain

Birdseye Ls., M. Ord.; Bucks Quarry, N. Y.

REFD: Walcott, 1883, p. 8 (1884, p. 214) ("varieties of *L. canadensis*") = **6985** (slab), **6986, 6987.** *Coll.* C. D. Walcott.

Eridoconcha magna Harris

See *Cryptophyllus magnus*

Eridoconcha simpsoni Harris

See *Cryptophyllus simpsoni*

Isochilina bilabiata Raymond

Highgate Ls., L. Ord.; Highgate, Vermont

HOLO: Raymond, 1937, p. 1128-1129, pl. 4 fig. 4 = **4453.** *Coll.* T. H. Clark.

Isochilina eximia Raymond

Highgate Ls., L. Ord.; Highgate, Vermont

HOLO: Raymond, 1937, p. 1129, pl. 4 fig. 3 = **4454** (on slab with *I. bilabiata* 4453). *Coll.* T. H. Clark.

Isochilina puteata Raymond

Highgate Ls., L. Ord.; Highgate, Vermont

HOLO: Raymond, 1937, p. 1128, pl. 4 fig. 5 = **4452.** *Coll.* T. H. Clark.

Isochilina tenuifilum Raymond

Highgate Ls., L. Ord.; Highgate, Vermont

HOLO: Raymond, 1937, p. 1128-1129, pl. 4 fig. 2 = **4451.** *Coll.* T. H. Clark.

Krausella arcuata Ulrich

Bromide F., M. Ord.; Arbuckle Mts., Okla.

FIGD: Harris, 1931, p. 94, pl. 14 fig. 4 a-c; Amsden, 1957, p. 22 = **7449.** *Coll.* R. W. Harris.

Leperditella? deckeri Harris

See *Balticella deckeri*

Leperditia (Isochilina) armata Walcott

See *Pteroleperditia armata*

Leperditia canadensis Jones **var.** Walcott

See *Eoleperditia nana?*

Leperditia gibbera var. **scalaris** Jones

See *Leperditia scalaris*

Leperditia ovata Jones

The slab 6972 bearing three leperditiids was identified as Jones' 1858a, p. 252 holotype by Cushman, 1907, p. 260

("12879"). The specimens are preserved with the matrix-filled, concave inside of the shell exposed, however, and hence these cannot be Jones' types.

Leperditia pennsylvanica Jones

Plate 1, figure 5.

Surgent Gr., M. Sil.; Barre Forge, Pa.

SYN: Jones, 1858a, p. 251-252, pl. 10 fig. 12a, b; 1858b, p. 834, fig. 699 left; Lesley, 1889, p. 90, fig.; Cushman, 1907, p. 260 = **6967** (on slab 6968). Jones, 1858a, p. 251-252 ("specimen of greyish limestone"); 1858b, p. 834 = **6968** (slab with many specimens). Jones, 1858a, p. 252, pl. 10 fig. 13; 1858b, p. 834, fig. 699 right; Lesley, 1889, p. 90, fig.; Cushman, 1907, p. 260 ("12875") = **6969.** Jones, 1858a, p. 252 (fragments with "numerous specimens"); Cushman, 1907, p. 260 ("12875, 12877") = **6970, 6971.** *Coll.* H. D. and W. B. Rogers.

Leperditia radiata Ulrich

See *Elpinella radiata*

Leperditia scalaris Jones

Scalent Gr., L. Dev.; Pa.

SYN: Jones, 1858a, p. 250-251, pl. 10 fig. 10a, b; 1858b, p. 834, fig. 698e; Swartz, 1949, p. 313 = **6960.** Jones, 1858a, pl. 10 fig. 11; 1858b, p. 834, fig. 698d = **6961.** Jones, 1858a, p. 251 ("fragment of an individual") = **6962.** P. 251 ("left valve") = **6963.** P. 250 = **6964, 6965.** Specimens 6960-6965 occur on a slab from Pennsylvania (Jones, 1858a, p. 250-251; 1858b, p. 834; Cushman, 1907, p. 260) and not New York (*cf.* Jones, 1858a, p. 257; Bassler, 1915, p. 705; Bassler and Kellett, 1934, p. 399; Swartz, 1949, p. 313).

REFD: Jones, 1858a, p. 251 ("A thin seam of hard grey limestone"); 1858b, p. 834; Cushman, 1907, p. 260 ("12878") = **6966.** *Coll.* H. D. and W. B. Rogers.

Paraschmidtella perforata (Harris) Swartz

Oil Creek F., M. Ord.; Arbuckle Mts., Okla.

HOLO: Harris, 1931, p. 87, pl. 5 fig. 4a, b; Amsden, 1957, p. 9 = **7446.** *Coll.* R. W. Harris.

Primitia variostriata (Clarke) Matern

Kiln Sh., U. Dev.; Pocahontas, Alberta

REFD: Burgess, 1931, p. 200 = **4468**/1-7. *Coll.* C. H. Burgess.

Primitiopsis bassleri Harris
See *Anisocyamus bassleri*

Pteroleperditia armata (Walcott) Hamada
Birdseye Ls., M. Ord.; Buck's Quarry, N. Y.
SYN: Walcott, 1883, p. 7-8 (1884, p. 213-214), pl. 17 fig. 10; Wilson and Mather, 1916, pl. 2 fig. 7; Kesling, 1958, p. 146; Harris, 1960b, p. 212-213 = **6983.**
Black River Ls., M. Ord.; Buck's Quarry, N. Y.
Walcott, 1883, p. 8 (1884, p. 214) = **6984.** *Coll.* C. D. Walcott.

Velibeyrichia moodeyi (Ulrich and Bassler) Henningsmoen
Plate 1, figure 6.
Onondaga Salt Gr., U. Sil.; Penn's Valley, Pa.
FIGD: Jones, 1858a, p. 252-253, pl. 10 fig. 15a, b ("*B. maccoyiana* Jones"); 1858b, p. 834, fig. 695; Jones and Holl, 1886, p. 347, 357 ("*B. pennsylvanica* Jones"); Jones, 1889, p. 340 footnote; Lesley, 1889, p. 90, fig.; Cushman, 1907, p. 259; Ulrich and Bassler, 1908, p. 285 footnote ("*B. moodeyi*"); 1923, p. 655 = **6973** (on slab 6974).
REFD: Jones, 1858a, p. 252-253 = **6974** (slab with "numerous individual valves"). *Coll.* H. D. and W. B. Rogers.

CIRRIPEDIA

Balanus gregarius (Conrad) Pilsbry
Bituminous Sh., U. Mio.; Hills N. of Buena Vista Lake, Calif.
FIGD: Gabb, 1869, p. 61-63, pl. 18 fig. 22 = **1829.** *Coll.* Gibbes.

Tamiosoma gregaria Conrad
See *Balanus gregarius*

PHYLLOCARIDA

Callizoe bohemica Barrande
U. Koněprusy Ls., L. Dev.; Koněprusy, Czech.
FIGD: Rolfe, [In press] = **6067**/6. *Coll.* J. M. von Schary.

Caryocaris raymondi Ruedemann
Athens Sh., M. Ord.; Clifton Heights, Tenn.
SYN: Ruedemann, 1934, p. 92-93, pl. 23 fig. 1, 2 = **7014.** P. 92-93, pl. 23 fig. 3 = **7015.**
FIGD: Ruedemann, 1934, pl. 23 fig. 4 = **7016.** Pl. 23 fig. 5 = **7017.** Pl. 23 fig. 6 = **7018.** *Coll.* P. E. Raymond.

Caryocaris raymondi? Ruedemann
Athens Sh., M. Ord.; Clifton Heights, Tenn.
FIGD: Ruedemann, 1934, pl. 23 fig. 10 = **7019**a; pl. 23 fig. 12 = **7019**b. Pl. 23 fig. 11 = **7020.** Furcal rami, not carapaces (*cf.* Ruedemann, p. 130). *Coll.* P. E. Raymond.

Ceratiocaris acuminata J. Hall
Bertie Waterlime, U. Sil.; Buffalo, N. Y.
FIGD: Stose, 1894, p. 370-371, 2 figs.; Cushman, 1907, p. 260 = **5997**/1. Stose, 1894, p. 370-371 ("antennae" are tail spines of small individual, probably *C. maccoyana* Hall) = **5997**/2. *Coll.* G. W. Stose.

Ceratiocaris? cornwallisensis Copeland
Budňany Beds, U. Sil.; Dvorce, Czech.
FIGD: Rolfe, 1962d, p. 914; 1963, p. 486-487, fig. 1: [In press] = **6095**/6.
REFD: Rolfe, 1963, p. 486 = **6095**/12. *Coll.* J. M. von Schary.

Ceratiocaris noetlingi Schmidt
Ludlovian, U. Sil.; W. Sarema, U.S.S.R.
REFD: Rolfe, 1962d, p. 927 = **7067**/1. *Coll.* W. Patten.

Ceratiocaris papilio Salter *in* Murchison
Ceratiocaris Beds, M. Sil.; Lesmahagow, Scot.
FIGD: Rolfe, 1962d, p. 917, pl. 129 fig. 2 = **5994**/23. P. 927, pl. 131 fig. 5, 6 = **5993**/1b. P. 927, pl. 132 fig. 3 = **5994**/24. P. 919, pl. 132 fig. 4 = **5994**/10.
REFD: Rolfe, 1962d, p. 914, 917, 919 = **5994**/5, 6, 8 (on same slab), **5994**/1a/b, 11-22.

Dithyrocaris paradoxides (de Koninck)
Visé Ls., L. Carb.; Visé, Belg.
FIGD: Rolfe, [In press] = rubber mold of **6025**/6. [In press] = reconstr. based on **6019**/2, **6020, 6023, 6024**/2-3a/b, 5-6, **6025**/1, **6027**/2a/b, **6028**a/b, **6029**/3a/b, **6031**/1-3, **6048.** *Coll.* L. G. de Koninck.

Nahecaris stuertzi Jaekel
Hunsrück Sh., L. Dev.; Bundenbach, Ger.
REFD: Raymond, 1932, p. 33; 1935, p. 222-223; Rolfe, [In press] = **7030.** *Coll.* T. Barbour.

Ohiocaris wycoffi Rolfe
Chagrin Sh., U. Dev.; Painesville, Ohio
PARA: Rolfe, 1962a, p. 1, 4-6 = **6556.** *Coll.* R. Pritschan.

Orozoe mira Barrande
U. Koněprusy Ls., L. Dev.; Koněprusy, Czech.
FIGD: Rolfe, [In press] = **6045**/26. *Coll.* J. M. von Schary.

SYNCARIDA

Uronectes fimbriatus (Jordan) Bronn
Rotliegend, L. Perm.; Lebach, Saarland, Ger.
REFD: Rolfe, 1962b, p. 548 = **6061.** *Coll.* H. G. Bronn.

Palaeocaris canadensis Brooks
Riversdale Gr., L. Penn.; Cumberland Co., Nova Scotia
HOLO: Copeland *in* Baird, 1962, p. 27 ("B-13: *Palaeocaris typus*?"); Brooks, 1962, p. 248-250, pl. 65, fig. 1, 2 = **5435.** *Coll.* D. and L. B. Baird.

The numerous MCZ specimens of non-decapod Eumalacostraca cited by Brooks, 1962, could not be itemized in time for this catalogue. Brooks refers to the MCZ numbers of all specimens he cites, however, so that his work is self explanatory. In curating the specimens concerned it was found that several parts had become separated from and catalogued independently of their respective counterparts. Wherever possible part and counterpart were reunited and renumbered to follow Brooks' 1962 account (available to the writer in thesis form in August, 1962). To remain consistent the following changes should be made to the MCZ numbers cited by Brooks, 1962: p. 180, for 5206 read 5230b; p. 182, for 5224 read ?5229b; p. 236, for 5233 read 5224b; p. 237, pl. 59 fig. 7, for 5224 read 5224a.

DECAPODA

Archaeoplax signifera Stimpson OD
Greensand Bed, U. Mio.; Gay Head, Mass.
SYN: Stimpson, 1863, p. 583-589, pl. 12 fig. 1-4; Packard, 1900, p. 1, 7; Cushman, 1905, p. 383 = **6489**/1-96, **6490, 6501.** *Coll.* A. Ordway. Also **6491**/ 1-58, **6492**/ 1-6, **6493**/1-7. *Coll.* A. Hyatt and N. S. Shaler. Cushman, 1905, pl. 2, fig. 3 = ?**6490.**

Eryma minuta (Schlotheim) Oppel
Lithographic Ls., U. Jur.; Solnhofen, Ger.
REFD: Reuss, 1850, p. 31 ("*Glyphea fuciformis*") = **6126.** *Coll.* A. F. Eser.

Eryon arctiformis (Schlotheim) Bronn
Lithographic Ls., U. Jur.; Solnhofen, Ger.
REFD: Reuss, 1850, p. 31 = **6104.** *Coll.* A. F. Eser.

Glyphea gratiosa (Meyer) Oppel
See *Selenisca gratiosa*

Grapsus speciosus Meyer
See *Potamon speciosum*

Harpactocarcinus punctulatus (Desmarest) A. Milne-Edwards
Grobkalk, Eoc.; Verona, N. Italy
FIGD: Meyer, 1862, p. 167-168, pl. 18 fig. 1, 2; Meyer, 1846, p. 463-464 (''*Cancer punctatus*'' *nom. null.*); Reuss, 1850, p. 20 = **6384.** *Coll.* A. F. Eser.

Harpactocarcinus quadrilobatus (Desmarest) Bittner
Nummulit, M. Eoc.; Kressenberg, Ger.
FIGD: Meyer, 1862, p. 156-157, pl. 16 fig. 12-14 (HOLO of *Xanthopsis kressenbergensis*); Meyer, 1846, p. 463 (*nom. nud.*); Reuss, 1850, p. 25; Milne-Edwards, 1863, p. 323-324, pl. 5 fig. 3, 3a; Cushman, 1907, p. 259, 262 = **6383.** *Coll.* A. F. Eser.

Linuparus (Eolinuparus) kleinfelderi Rathbun
Drift, U. Cret.; Long Island, N. Y.
FIGD: Rathbun, 1935, p. 35-36, pl. 25 fig. 1, 2; Raymond, 1932, p. 33 = **6255**a; Rathbun, 1935, pl. 25, fig. 3 = mold of **6255**b. *Coll.* E. H. E. Wing.

Mecochirus longimanatus (Schlotheim) Bronn
Lithographic Ls., U. Jur.; Solnhofen, Ger.
REFD: Reuss, 1850, p. 31 (''*Megachirus bajeri, M. brevimanus*'') = **5897**/1-4. *Coll.* A. F. Eser.

Mecochirus socialis (Meyer) Quenstedt
Oxfordthon, U. Jur.; Dettingen, Ger.
?SYN: Meyer, 1841, p. 96; 1847, p. 144-148 = **6244**/1-8. *Coll.* F. von Mandelsloh, 1840. **6317**/1-3 were not collected by Mandelsloh until 1845, according to the original label, and hence these cannot be syntypes. All purchased from H. G. Bronn, 1859.
REFD: Reuss, 1850, p. 44 (''*Glyphaea munsteri*'') = **6519.** *Coll.* A. F. Eser.

Pemphix sueuri (Desmarest) Meyer
Muschelkalk, M. Trias.; Württemberg, Ger.
REFD: Reuss, 1850, p. 50 = **6269-6274.** *Coll.* A. F. Eser.

Potamon speciosum (Meyer) Rathbun
Molasse, U. Mio.; ?Oeningen, Switz.
REFD: Meyer, 1862, p. 169 (''Einem dritten, weniger deutlichen Exemplar'') = **6347.** *Coll.* A. F. Eser. Specimens **6344-6346** and probably also **6348-6350** were collected by O. Heer and may be those on which Heer's 1865 figures are based (p. 353-358, fig. 207, 208).

Prosopon laeve Meyer
L. Kimm., U. Jur.; Gundershofen, France

REFD: Reuss, 1850, p. 41 ("*Prosopon simplex*") = **3217.** *Coll.* A. F. Eser.

Pseudoglyphea ancylochelis (Woodward) Woods
L. Lias, L. Jur.; Lyme Regis, Eng.
PARA: Woodward, 1863, p. 318 = **6266, 6267.** *Coll.* J. W. Marder.

Ranina marestiana König
Nummulit, M. Eoc.; Sonthofen, Ger.
REFD: Reuss, 1850, p. 24 ("*Ranina aldrovandi* (Ranzoni)" *sic*) = **6400.** *Coll.* A. F. Eser.

Scapheus ancylochelis Woodward
See *Pseudoglyphea ancylochelis*

Selenisca gratiosa Meyer OD
Plate 1, figure 8.
Kimm., U. Jur.; Würmlingen, Ger.
HOLO: Meyer, 1847, p. 141-144, pl. 19 fig. 1; Reuss, 1850, p. 41 ("Hermann v. Meyer bemerkt brieflich (1846): merkwürdig ist es, dass dieser Krebs von jenen des Solenhofer Schiefers verschieden sich darstellt. Er gehört einem eigenen den Glypheen nahestehenden Genus an."); Oppel, 1862, p. 70-72, pl. 18 fig. 1a, b; Beurlen, 1928, p. 152-153; Cushman, 1907, p. 261 = **6245.** *Coll.* A. F. Eser.

Thelphusa [=*Telphusa*] **speciosa** Meyer
See *Potamon speciosum*

Xanthopsis bruckmanni Meyer, 1862 [=1845 *nom. nud.*] [=*X. hispidiformis* (Schlotheim) A. E. Reuss, *partim* (*nom. oblit.*)]
Nummulit, M. Eoc.; Sonthofen, Ger.
SYN: Meyer, 1862, p. 153-154, pl. 16 figs. 5-9; Reuss, 1850, p. 24; Cushman, 1907, p. 262; Schlosser, 1925, p. 144 = **6413.** Meyer, 1862, p. 154-155, pl. 16 fig. 10, 11; Cushman, 1907, p. 262; Schlosser, 1925, p. 144 = **6414.** Meyer, 1862, p. 155 ("eines anderes weiblichen Exemplars"); Schlosser, 1925, p. 144 = **6415.** *Coll.* A. F. Eser.

Xanthopsis kressenbergensis Meyer
See *Harpactocarcinus quadrilobatus*

Xanthopsis sonthofenensis Meyer
Nummulit, M. Eoc.; Sonthofen, Ger.
HOLO: Meyer, 1862, p. 159-161, pl. 18 fig. 7-9; Meyer 1846, p. 463 (*nom. nud.*); Reuss, 1850, p. 24; Milne-Edwards, 1863, p. 321-322; Schlosser, 1925, p. 144

("young *X. bruckmanni*"); Cushman, 1907, p. 259, 262 = **6418.** *Coll.* A. F. Eser.

MYRIAPODA

Euphoberia anguilla Scudder

Carbondale F., M. Penn.; Mazon Creek, Ill.

FIGD: Scudder, 1890a, p. 435-436, pl. 36 fig. 3; 1890b, p. 411-412, pl. 28 fig. 3 = **7431**a. *Coll.* F. T. Bliss.

Euphoberia armigera Meek and Worthen

Carbondale F., M. Penn.; Mazon Creek, Ill.

FIGD: Scudder, 1882a, p. 143, 160, 165-167, pl. 13 fig. 7; Lacoe, 1883, p. 17; Scudder, 1890b, p. 195, 212, 217-219, pl. 10 fig. 7 = **7432**a. *Coll.* F. T. Bliss.

Palaeocampa anthrax Meek and Worthen

Carbondale F., M. Penn.; Mazon Creek, Ill. Plate 1, figure 7.

FIGD: Scudder, 1883, p. 283-284, 294-295, pl. 26 fig. 5, 8, 9; 1882b, p. 161-162; Lacoe, 1883, p. 19; Scudder, 1890b, p. 247-248, 258-259, pl. 12 fig. 5, 8, 9 = **7430**a. Scudder, 1885, p. 726, fig. 894a; 1887, p. 725, fig. 911a; Nicholson and Lydekker, 1889, p. 583, fig. 438; Lesley, 1889, p. 579, fig. = **7430**b. *Coll.* F. T. Bliss.

Xylobius cf. **frustulentus** Scudder

See *Xyloiulus bairdi*

Xylobius spp.

See *Xyloiulus* spp.

Xyloiulus bairdi Hoffman

U. Freeport Coal, M. Penn.; Linton, Ohio.

HOLO: Hoffman, 1963, p. 171-172, pl. 24 fig. 2, 3; Baird, 1958, p. 239-240 (*Xylobius* cf. *frustulentus*) = **5268**a/b.

PARA: Baird, 1958, p. 239-240; Hoffman, 1963, p. 171-172 = **5320, 5321**a/b. *Coll.* D. and L. B. Baird.

Xyloiulus cf. **frustulentus** (Scudder) Cooke *in* Cooke and Collins.

See *Xyloiulus bairdi.*

Xyloiulus spp.

Morien Gr., M. Penn.; Florence, Nova Scotia

REFD: Baird, 1958, p. 240 = **5448-5450.** *Coll.* A. Lewis field party.

Arroyo Gr., L. Perm.; Coffee Creek, Texas

REFD: Baird, 1958, p. 239 = **5451.** *Coll.* A. S. Romer field party.

INCERTAE SEDIS

Anomalocaris canadensis Whiteaves
Burgess Sh., M. Cam.; Field, B. C.
FIGD: Rolfe, [In press] = **5976.** *Coll.* C. H. Burgess, P. E. Raymond, W. E. Schevill, and H. C. Stetson.

Aptychopsis prima Barrande
Liten Beds, L. Sil.-M. Sil.; Borek, Czech.
FIGD: Rolfe, [In press] = **6082**/9. P. R , fig. = **6082**/11.

Canadaspis perfecta (Walcott) Novojilov *in* Orlov
Burgess Sh., M. Cam.; Field, B. C.
FIGD: Rolfe, [In press]; Raymond, 1935, p. 221 = **5977**/70. *Coll.* C. H. Burgess, P. E. Raymond, W. E. Schevill, and H. C. Stetson.

Dictyocaris slimoni Salter
Downtonian, L. Dev.; Stonehaven, Scot.
FIGD: Rolfe, [In press] = **6224**/9b. *Coll.* P. E. Raymond and H. C. Stetson.

Hurdia victoria Walcott
Burgess Sh., M. Cam.; Field, B. C.
FIGD: Rolfe, [In press] = based on **5986**/13a. *Coll.* C. H. Burgess, P. E. Raymond, W. E. Schevill, and H. C. Stetson.

Hymenocaris perfecta Walcott
See *Canadaspis perfecta*

Nothozoe pollens Barrande
Drabov Quartzites, M. Ord.; Mt. Drabov, Czech.
FIGD: Rolfe, [In press] = **6081**/14. *Coll.* J. M. von Schary.

Proboscicaris agnosta Rolfe
Burgess Sh., M. Cam.; Field, B. C.
PARA: Rolfe, 1962c, p. 1, 3, 4, fig. 1 = **5979**/1. P. 1-4, fig. 1 = **5979**/2a/b. P. 1-4, fig. 1 = **5979**/3a/b. *Coll.* C. H. Burgess, P. E. Raymond, W. E. Schevill, and H. C. Stetson.

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PLATE

Plate 1

Type specimens of fossil arthropods in the Museum of Comparative Zoology

Figure		*Page*
1.	*Prolimulus woodwardi* Fritsch, MCZ 4694. × 2.6.	375
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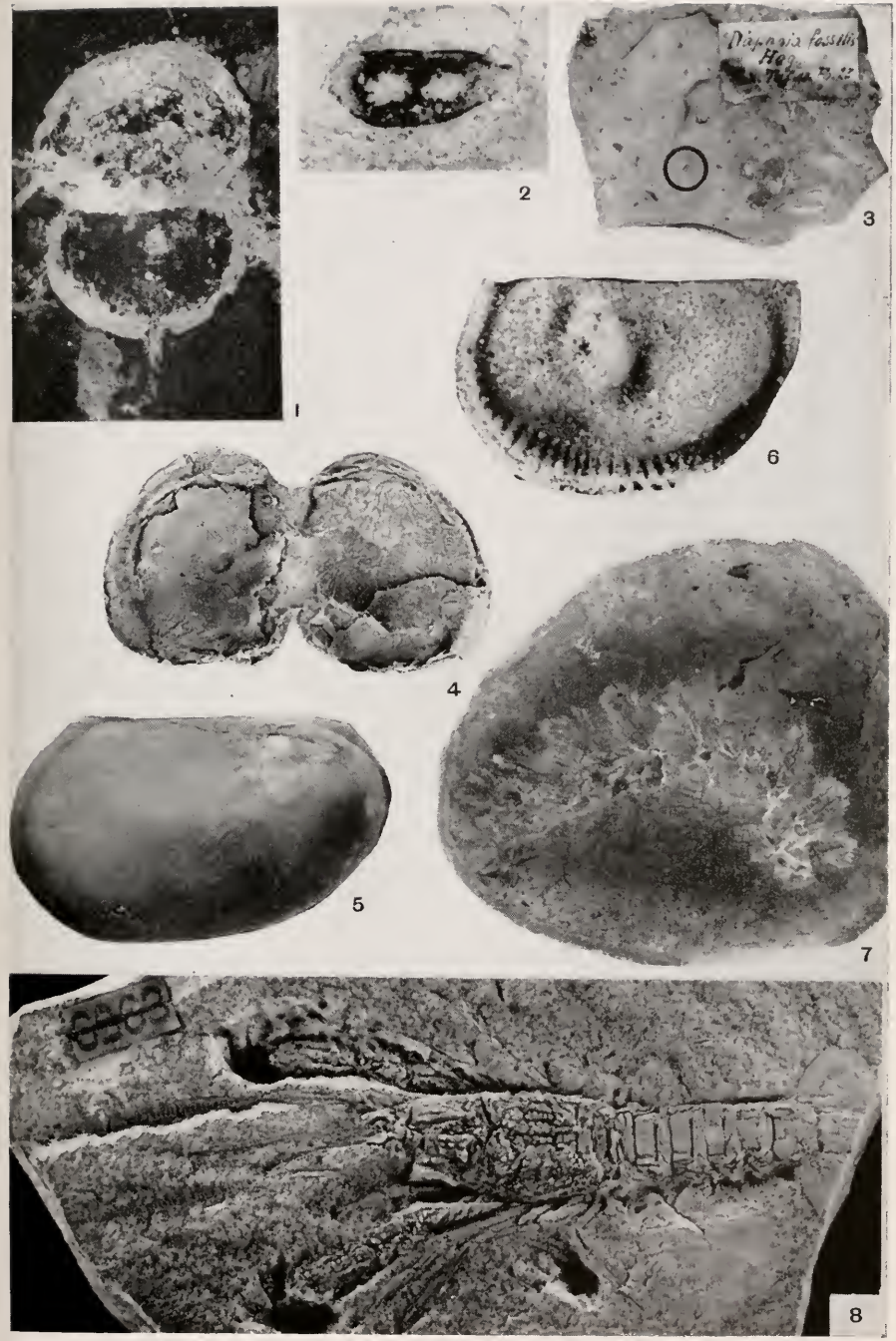
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Bulletin of the Museum of Comparative Zoology

AT HARVARD COLLEGE

VOL. 129, NO. 8

A REVIEW OF THE RECENT FRESHWATER LIMPET SNAILS OF NORTH AMERICA

(Mollusca : Pulmonata)

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CAMBRIDGE, MASS., U.S.A.

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Occasional Papers of the Department of Mollusks (octavo) 1945 — Vol. 2, no. 28 is current.

Proceedings of the New England Zoological Club (octavo) 1899–1948 — Published in connection with the Museum. Publication terminated with Vol. 24.

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No. 8 — *A Review of the Recent Freshwater Limpet Snails of North America (Mollusca: Pulmonata)*

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INTRODUCTION

The hypothetical ancestral mollusk is often described in zoology texts as a small animal with a bilaterally symmetrical shell and several pairs of gills, living upon the sea bottom in early pre-Cambrian times. In recent years a primitive monoplacophoran, *Neopilina,* has been found by Lemche and Clarke and others, answering more or less to such a description, and giving credence to the suggested "common ancestor." During

the last half-billion years the descendants of such an early mollusk have evolved into a wide spectrum of forms occupying a variety of aquatic and terrestrial habitats. Among modern mollusks, the freshwater limpets (which bear an amazing superficial resemblance to *Neopilina*) illustrate an interesting example of evolution, for in their phylogenetic history they have accumulated a series of advances and atavisms that may be unique among gastropods. The shape of the shell is roughly bilaterally symmetrical, even though these snails undoubtedly had coiled ancestors. Although they are pulmonates, the lung is vestigial and a secondary gill-like structure, the pseudobranch, has developed to suit their aquatic requirements; thus they may be descended from terrestrial ancestors and have secondarily re-invaded an aquatic habitat.

Within the group, stream forms appear to have given rise to pond forms, and some of the latter show evidence of repopulating stream habitats, giving rise to an exceedingly complex tangle of evolutionary convergences, parallelisms, and diversifications. The animals are responsive to changes in their physical environment, and reflect this sensitivity in modification of shell size and shape. Moreover, some populations of these normally hermaphroditic snails have lost the male genitalia, while retaining the ability to produce sperm cells in the ovotestis. In these populations, cross-fertilization is manifestly impossible, and the appearance of self-fertilization or parthenogenesis may have profound genetic effects upon the future development of the group. Certain populations are dimorphic, with some individuals possessing a conspicuous septum closing the posterior portion of the aperture, presenting a greatly modified growth pattern as compared with the "normal" members of the same population. This septate situation represents the only clear-cut case of conspicuous dimorphism among the Basommatophora. Furthermore, the septate, or non-septate, or both types may be aphallate.

The freshwater limpets are essentially world-wide in distribution, occurring in a variety of habitats in most temperate and tropical regions. Most species appear to fall within the poorly defined family Ancylidae (Menke, 1830), although a similar shell shape has developed independently several times in fresh waters in such unrelated groups as *Lanx* (see Baker, 1925), and *Acroloxus* (see Hubendick, 1962). The term "limpet" is merely descriptive of general shell shape and does not imply a relationship (e.g., with marine limpets) any more than do the terms "slug" and "sea slug."

Owing to the general state of ignorance regarding exotic species of freshwater limpets and the difficulties encountered in working with the North American forms, the drawing of taxonomic conclusions is an extremely precarious task.

In North America, freshwater limpets fall into six clearly distinguished groups. The genus *Ferrissia* is the most widespread geographically, has the greatest variety of species, and occupies the most diverse types of habitats. Other genera have fewer species and are found in more limited areas of the continent. Second in its extent of range is *Laevapex,* found usually in river backwaters and in bodies of standing water from Florida to Canada east of the Mississippi and around the Great Lakes region. The tropical genus *Hebetancylus* has been reported from Texas and southern Florida. A fourth group of limpets comprises the genus *Rhodacmea,* found until recent decades principally in the rivers of northern Alabama, Tennessee, and Kentucky, and in related drainages. Other freshwater limpets, only vaguely related to the four genera mentioned above, include *Acroloxus,* with one American species, reported only three times in the Rocky Mountains (but known as a fossil from the High Plains), and *Lanx,* a lymnaeid-like limpet restricted to rivers in Idaho, Washington, Oregon, and northern California, and not included in this study. (See Morrison, 1955, for a discussion of *Lanx.*) An additional group of five species of extremely tiny snails has also been classified with the freshwater limpets. Although coiled, these snails have been thought to be related to the ancylids by Pilsbry and others, and a separate subfamily, the Neoplanorbinae, was established by Hannibal in 1912 for the two genera *Neoplanorbis* and *Amphigyra.* These genera were restricted to the middle Coosa River in Alabama and are now all extinct. Their relationships are obscure, and there is nothing that I can add to a discussion of the group. Therefore, the interested reader is referred to papers by Pilsbry (1906), Walker (1908), Goodrich (1944), and Basch (1962b).

Ecologically, limpets may be found in almost any type of freshwater habitat. Smaller ponds and permanent ditches, especially those with abundant rooted vegetation, usually yield small limpets from the bottom few inches of the plant stems. Streams and smaller rivers of moderate flow, with cobble or boulder bottoms, and draining areas of calcareous soils, generally will have limpets living on the stones or other debris.

Ancylids are not generally found in torrential streams (such as those of the Rocky Mountains), nor in lakes or rivers with sand bottoms lacking suitable substrates. They will live in waters charged with organic matter (Wurtz, 1956), but appear to be intolerant of chemical pollution such as agricultural insecticides, industrial wastes, and detergents. The increasing use of such materials by farmers, manufacturing plants, and householders is causing serious reduction of the populations of limpets and many other types of freshwater organisms, and is turning previously productive streams into biological deserts, particularly in the east-central states. The great increase in damming of almost all large rivers in the United States has caused a precipitous decline in the distribution of river species, and has already resulted in the extinction of one subfamily (Neoplanorbinae). The subfamily Rhodacmeinae is also in danger of extinction from these causes.

The inconspicuous and frequently overlooked limpets are among the most widely distributed of all freshwater mollusks. I have found them in many localities from Florida to Washington where no other snails could be found; a diligent search usually turned up some specimens from any suitable habitat. As indicated above, the encroachment of civilization upon molluscan habitats has already been severe, and I fear that in the future these interesting animals may become rare in many parts of the country.

Freshwater limpets have been known to European naturalists since pre-Linnaean days, and were represented in the collections of the early American zoologists. In 1817 Thomas Say named the first American species (*Ancylus rivularis*), from the Wabash River in Indiana, inaugurating more than a century of study of this group by eminent American malacologists. The 1830's saw an additional name published by Say, as well as a new species from Alabama by Conrad. By 1850 species had been described from Massachusetts, Ohio, New England, New York, Oregon, and Virginia, as the continent became better explored. During the last half of the nineteenth century more than a dozen new names were published in this group. In the first three decades of the present century the number of species names more than doubled owing to the efforts of scholars such as Pilsbry and Walker, but the group has remained relatively unstudied since about 1930.

Biological studies on North American ancylids are few.

While the anatomy of the European river limpets was fairly well known before the turn of the century (Sharp, 1883; Andre, 1893), it was not until 1940 that the first critical work was done on an American species by Hoff, although fragments of anatomical information were occasionally included in studies of other types (e.g., Baker, 1928). Eggs and young were described by Clapp (1921), and in the past few years the present author has published a number of papers on the biology and anatomy of these peculiar mollusks.

No study of a group of snails is complete without a consideration of the trematode parasites utilizing them as intermediate hosts. Significant early work on trematode parasites of ancylids was carried out in South Africa by Cawston during the period 1917-1930. The comparative parasitization of various freshwater snails, including ancylids, was discussed by McCormick (1923), but no infection was found in limpets inhabiting the Olentangy River, Ohio. The papers by Smith (1953a, b, 1959) were the first directly concerned with trematode parasites of ancylid snails in North America. Parasites utilizing this group may be of great interest because of the recent revelations by Gadgil and Shah (1955) and Shah and Gadgil (1955a, b) that an ancylid snail in India, *Ferrissia tenuis*, can act as intermediate host for the human blood fluke, *Schistosoma haematobium*. Hubendick (1958) has published a brief account of the ancylid host. It has been my experience to find that trematode parasites are far more common than had been suspected. Of 150 collections made during the summer of 1961 in 23 states, 22 (about 15%) were found to be heavily infected with one or more species of trematodes, which have not yet been identified.

Methods

Museum material was used for a comprehensive study of shells and also in some cases for extraction and preparation of radulae from the dried specimens. Principal collections studied were from the University of Michigan Museum of Zoology (UMMZ), United States National Museum (USNM), Academy of Natural Sciences of Philadelphia (ANSP), Museum of Comparative Zoology of Harvard University, Cambridge (MCZ), American Museum of Natural History (AMNH), Carnegie Museum of Pittsburgh (CAR), and National Museum of Canada (NMC). Almost nothing could be done in terms of anatomical

study of such specimens, however, and it was necessary to make an extensive collecting trip in order to obtain enough properly prepared specimens for dissection. This collecting trip was made in nine weeks during June, July, and August, 1961, and approximately 12,000 animal specimens were obtained from 150 localities.

Specimens were collected from vegetation, debris, stones, or other substrates by lifting them off carefully with a scalpel blade. An attempt was made at each locality to secure a representative sample including all size classes. Field notes, taken on a standard form, included information on locality, habitat type, size, and character, turbidity, current, bottom type, debris, vegetation, depth, substratum, and other pertinent information. If available, five or more large specimens were placed immediately in the chromosome-fixing solution described by Newcomer (1953). The rest of the animals were maintained in water in numbered screw-capped vials which were placed in crushed ice in a wide-mouthed Dewar flask. Each evening the day's collection was removed from the vials and placed in a 1 per cent solution of veterinary Nembutal (60 mg./ml. Sodium Pentobarbital, Abbott) in local tap water in stacking 11 cm. laboratory finger bowls, and permitted to relax overnight (see van der Schalie, 1953). The following morning samples of each collection were fixed for later study. If only a few specimens were taken, they were placed in 70 per cent ethyl alcohol, in which shells are not damaged and soft parts moderately well preserved. Where larger numbers of limpets were collected, samples were also preserved in 10 per cent formalin, formalin-acetic acid-alcohol (FAA) mixture, and Bouin's solution. Each evening all animals fixed that morning were changed to 70 per cent alcohol, which was again changed for fresh alcohol several days later. Newcomer's solution, where used, was also changed for fresh after a day, and again after a few weeks. Upon arrival at the laboratory in Emporia (at the most, six weeks after collection), all solutions were again changed. Vials containing the specimens in preservative were packed into tightly sealing quart-sized canning jars to prevent evaporation. Specimens remained in excellent condition through this protocol, and none decomposed. In the laboratory, jars containing specimens have been stored in the refrigerator at 8° to 10° C.

Each specimen collected has been examined. Approximately fifty animals were embedded in paraffin and sectioned at 12 to

15 microns. Dozens of radulae have been extracted and mounted on slides, and several hundred individuals have been completely dissected. Temporary mounts of genitalia were prepared in glycerin and examined with a compound miscroscope, usually at 100 to 450 X magnification.

Records of observations have included the usual notes and sketches, stereo photomicrographs of dissections (using a graflex stereoscopic camera on a Spencer Cycloptic microscope), and photographs and camera lucida drawings of radulae, genitalia, and shells.

In the key below and the discussion following it, I have made a sincere effort to base all of my judgments and decisions upon evidence provided by the specimens themselves. In the past, other workers have come to different conclusions regarding the validity of species and the relationships between them, and I have no doubt that a restudy of the same material by others may lead to still different interpretations.

The general philosophy guiding species discrimination has been this: the precise shape of the shell is dependent upon genetic and environmental factors, and a difference in shape between two individuals or populations may be a reflection of the latter rather than an indication of genetic diversity. Wherever possible, representative samples from natural populations have been compared to accumulate a picture of seasonal, regional, and ecophenotypic variation unobtainable from one or a few specimens. Type specimens and descriptions have been compared with these population series, and where significant overlap of characters was found in such a manner that specific distinction could not be clearly stated, all specimens in the group were considered to be conspecific, and names placed in the appropriate synonymy. Such an approach inevitably leads to a reduction in the number of names considered valid, and an expansion in the variability of the remaining species. Even with the smaller number of names and the generally simplified classification presented here, unequivocal specific determinations are often difficult or impossible to make, owing to the enormous variability of the animals themselves and our general ignorance concerning it. In the last analysis, subjective decisions have had to be made, sometimes based upon small numbers of specimens or insufficient data, but it is my conviction that the present scheme represents a closer approximation to the actual phylogenetic situation in this difficult group than has previously been available.

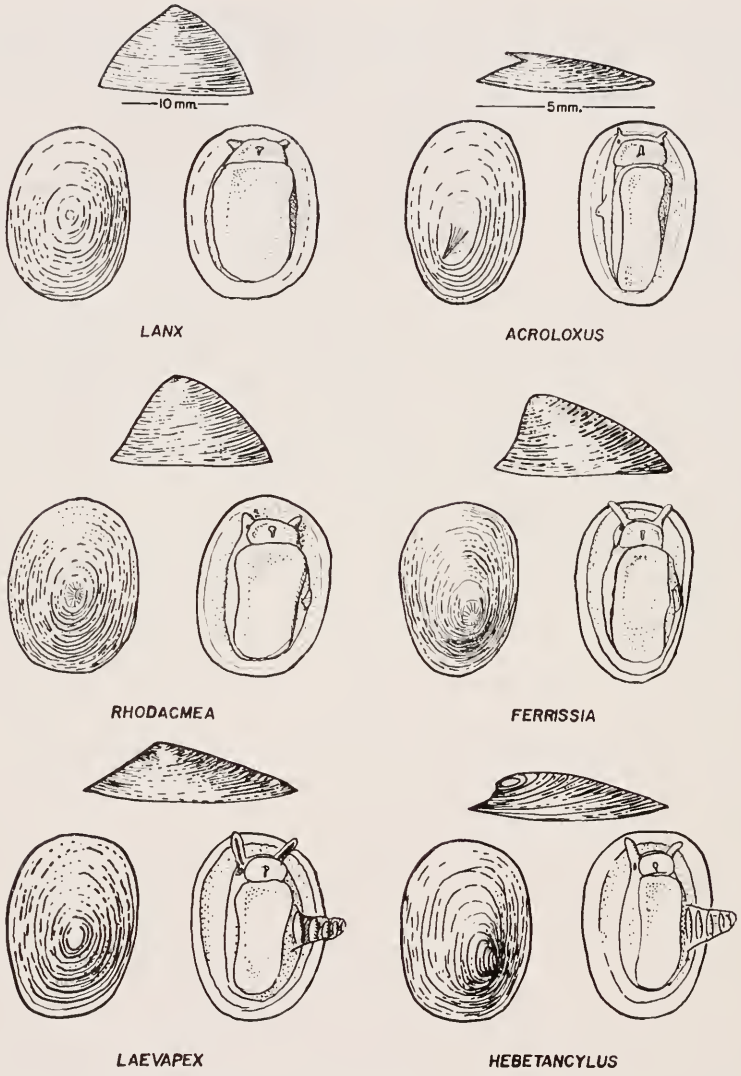

FIG. 1. Shells and animals of North American freshwater limpets. Shells illustrated are of typical specimens, and variation from these shapes should be expected. Dimensions of genera where scale is not indicated are similar to those of *Acroloxus*. Animal of *Acroloxus* adapted after Hubendick, 1962.

Acknowledgments

This study would not have been possible without the generous assistance of many persons. Specimens have been made available by the following museum curators: Dr. Arthur H. Clarke, Jr., of the National Museum of Canada, Dr. William J. Clench of the Museum of Comparative Zoology, Harvard University, Dr. William K. Emerson of the American Museum of Natural History, Dr. Juan J. Parodiz of the Carnegie Museum, Dr. Harald A. Rehder and others at the United States National Museum, Dr. Alan Solem of the Chicago Natural History Museum, and Dr. Henry van der Schalie of the University of Michigan Museum of Zoology. Other specimens have been sent by Robert J. Drake of the University of British Columbia and Fred G. Thompson of the University of Miami. In the field, Dr. Donald Baepler in Ellensburg, Washington, Mrs. Dorothy E. Beetle in Laramie, Wyoming, Mr. Walter J. Eyerdam in Seattle, Washington, Dr. Kenneth Perkins in Elon College, North Carolina, Dr. Claire Schelske in Sapelo Island, Georgia, and many others have been of great assistance. I should also like to thank Edward Garner, Mrs. Nelda Davis, Mrs. Jo Lynne Dick, Miss Judy Pitcher, and Jack Woodhead for their assistance in field and laboratory work associated with this project.

I am genuinely grateful to the National Science Foundation for their financial support, and also for their interest and enthusiasm. This work was supported by NSF Grant #G 14125.

Finally, I wish to record a debt of gratitude to a man whom I have never met — a man whose active career ended, in fact, before my birth. His enthusiasm and skill, reflected in his many publications, have inspired several generations of American malacologists. His collections, now at the University of Michigan Museum of Zoology, have formed an important nucleus for this study, and specimens collected or identified by him are to be found in every important museum in America. Without the prior work of the late Dr. Bryant Walker, the present paper could not have been written.

Although many of the persons named above have helped significantly to frame my ideas about ancylid systematics, all conclusions presented here (including such erroneous ones as there may be) are my own, for which I take full responsibility.

All illustrations are by the author.

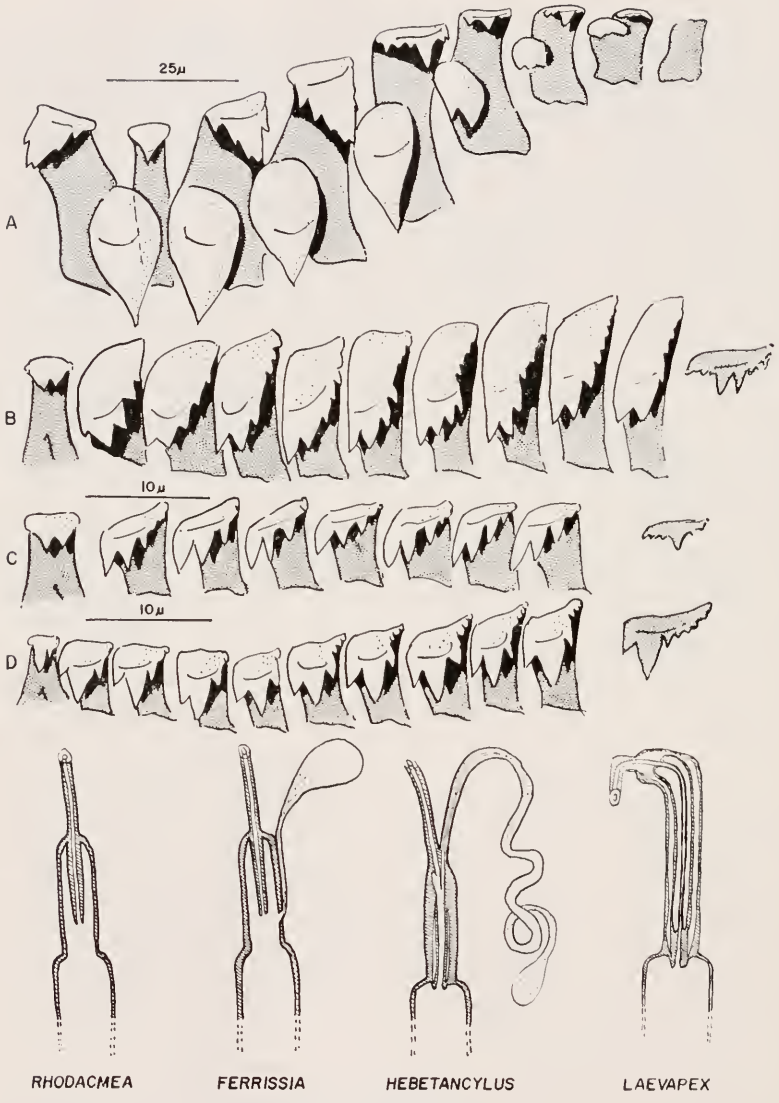

FIG. 2. Radulae and male genitalia of North American Ancylidae. A, *Rhodacmea;* B, *Ferrissia;* C, *Laevapex;* D, *Hebetancylus.* Radulae are variable, and those illustrated are typical. Distinction of *Ferrissia, Laevapex,* and *Hebetancylus* on the basis of the radula alone is not practicable. Genitalia of the four genera are illustrated below. These do not vary greatly and are reliable generic indicators.

Key to Genera of North American Freshwater Limpets

1 a. Apex of shell in front of center and slightly to the left, more evident in young individuals. Shell when mature to 18 mm. long. Animal dextral, with genital and (vestigial) respiratory openings on right side. Radula similar to that of Lymnaeidae. Confined to rivers, northwestern states ..... *Lanx* (*sensu lato*)

b. Apex of shell usually behind center. Shells relatively small, less than 10 mm. long. Animal dextral or sinistral. In all regions, in streams, lakes, ditches 2

2 a. Shell depressed, apex sharply acute, prominent, directed posteriorly and to the left, strongly striate. Peritreme arched. Radular rows chevron-shaped. Animal dextral. In lakes in Rocky Mountain area, extremely rare ..... *Acroloxus*

b. Shell depressed or elevated, apex prominent or obtuse, in the midline or directed to the right, striate or smooth. Peritreme arched or flat. Radular rows straight. Animal sinistral. Widely distributed, in many different habitats 3

3 a. Shell elevated, apex in midline, tinged with pink or red inside and out, radially striate, with a notch-shaped depression evident in unworn specimens. Peritreme broad, flat. Radular teeth in rows about 30 microns apart, with prominent inner cusps (Fig. 2). Penis simple, without a flagellum. In rivers, southeastern states ..... *Rhodacmea*

b. Shell elevated or depressed, apex in midline or to the right, the same color as the rest of the shell, finely radially striate or smooth. Peritreme arched or flat, broad or narrow. Radular teeth in rows about 6-10 microns apart, without prominent inner cusps (Fig. 2). Penis with or without a flagellum. In running or standing water, widely distributed 4

4 a. Shell usually elevated, but variable. Apex with fine radial striae, often eroded in older specimens. Peritreme narrow to broadly ovate; aperture entirely open or with a horizontal shelf-like septum closing the posterior part. Pseudobranch of one lobe, flat. Penis with a flagellum. Widely distributed in streams and standing water ..... *Ferrissia*

b. Shell usually depressed. Apex smooth, with no trace of radial striae. Peritreme ovate to subcircular; aperture always open. Penis with or without a flagellum. Pseudobranch of two lobes, the lower of which is elaborately folded. In standing water, principally in eastern states and south 5

5 a. Apex very obtuse, almost in the midline of the shell. Penis without a flagellum; preputium flecked with pigment spots. Tentacles with a central core of black pigment. In ponds and river backwaters, principally east of the Mississippi; occasionally in streams in south-central states ..... *Laevapex*

b. Apex subacute, distinctly eccentric, to the right of the midline. Penis with a long glandular flagellum terminating in a bulbous tip; preputium without pigment. Tentacles colorless. In canals, etc., in southern Florida, and perhaps west to Texas..... *Hebetancylus*

Genus ACROLOXUS Beck, 1837

Type species. Patella lacustris Linnaeus, 1758

ACROLOXUS COLORADENSIS (Henderson)

Ancylus hendersoni Walker, 1925, Occ. Pap. Mus. Zool. Univ. Mich. 165: 1, pl. I, figs. 1-2; pl. II, fig. 1. Eldora Lake, Boulder County, Colorado; non Walker 1908.

Ancylus coloradensis Henderson, 1939, Nautilus 44: 31. [New name for *hendersoni* Walker 1925, non 1908.]

Acroloxus coloradensis (Henderson). Taylor, 1960, U. S. Geol. Surv. Prof. Paper 337: 61.

Description: "Shell oval, slightly wider anteriorly, very much depressed, light horn color; anterior and posterior margins regularly rounded, lateral margins about equally curved, the right somewhat more than the left; anterior, posterior and right lateral slopes straight, left lateral slope slightly incurved; apex very acute, almost spine-like, eccentric, turned towards the left side, situated at about 2/5 of the length from the posterior margin and at about 1/3 of the width from the left margin, radially striate, the striae continuing over the surface of the shell from the apex to the margins; surface with fine and regular lines of growth and delicately radially striate. Length 5, width 3, alt. 1 mm." — Walker

Types: UMMZ 102549 (H- Holotype); Univ. Colorado Museum 10113.

Distribution: The Eldora Lake locality (Colorado) is the only one known in the United States for this peculiar limpet, and to my knowledge it has been found there only once. Alan Mozley collected the species in two lakes in Alberta, Canada: Lake Iris in 1925, and "Lake north of Geikie Station" in 1926 (specimens at ANSP, 152666).

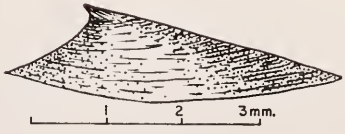

FIG. 3. *Acroloxus coloradensis,* type, UMMZ 102549. Boulder County, Colorado.

Ecology: Practically nothing is known about the ecology of *A. coloradensis*, but according to Henderson (*in* Walker, 1925), "We found them only clinging to stones, etc., in very tiny inlets from the lake, where they were well protected from the waves, but in clear water, not in swampy ground." I have examined Henderson's notebooks at the University of Colorado Museum and find that the type specimens were collected on July 28, 1920, in fresh beaver workings at the northwest corner of Eldora Lake, together with "*Pisidium, Planorbis,* and 4 small *Lymnaea.*" The elevation of Eldora Lake is 9100 feet, and that of Lake Iris is 4285 feet above sea level. (See Mozley, 1954, p. 2, fig. 1, for a photograph of a Canadian locality.)

Morphology: I have not had an opportunity to examine the soft parts of this species, but Baker (*in* Walker, 1925) found the animal to be dextral with the gill running along the right side of the posterior end. The radula is as in the European *Acroloxus.* Baker (*loc. cit.*) compared a radula from Colorado with one from Germany; I have prepared one from Canada and one from the Netherlands kindly sent to me by Dr. W. S. S. van Benthem Jutting, and find them to be identical except that the Canadian radula is smaller. The anatomy of the European *Acroloxus lacustris* has recently been described by Mirolli (1958) and Hubendick (1962).

Remarks: I have searched the vicinity of Eldora Lake but have not been able to find any kind of limpets, either in the lake proper or in the small streams and swamps adjacent to it. Dr. Robert Pennak of the University of Colorado, who helped me a great deal in my search, has collected at the lake a number of times in recent years, but neither he nor anyone else has been able to locate additional specimens. In fact, Henderson himself was unable to locate any more, even though Bryant Walker pleaded with him (in a note) to do so. Taylor (1960) has recently found shells of this species in the early Pleistocene of southern Kansas and north-central Nebraska indicating that in former times these high plains areas had more aquatic habitats than at present.

Acroloxus lacustris is a widely distributed and relatively abundant mollusk in Europe, ecologically the equivalent of such American species as *Ferrissia parallela* and *Laevapex fuscus. Acroloxus* was presumably more widespread in North America, becoming restricted with increasing dryness of the habitats in

the central United States, and remaining as a few relic populations in the Rocky Mountains where other limpets are generally not found.

The relationship of *Acroloxus* to ancylids is tenuous at best, and the genus might well be placed in a distinct family as suggested by Bondesen (1950), Zilch (1959), and Hubendick (1962) in his thorough review.

Genus RHODACMEA Walker, 1917

Type species. Ancylus filosus Conrad, 1834

The strangely indented, pink, striated apex, and the peculiar radula distinguish *Rhodacmea* clearly from all other freshwater limpets. The genus is undoubtedly approaching extinction as more and more fast-flowing larger streams and rivers in the southeastern United States are rendered unsuitable as habitats by dams and pollution. Previous records of *Rhodacmea* place it in the mountain drainages of Kentucky, Tennessee, and Alabama, with populations north into Illinois and Indiana. I have collected in dozens of streams in these areas and have located living *Rhodacmea* only in the Cahaba River near Helena, Alabama (Basch, 1960). Other living populations probably still exist.

I find Walker's (1917) division into subgenera untenable, since the radular characters given by him are not sufficiently constant for taxonomic reliance (Basch, 1962a). I am able to distinguish three shell types, which may represent ecological variants of a single relatively unstable phylogenetic twig. Distribution patterns do not substantiate such a division, but since such critical localities as the Tennessee River and the Coosa River are permanently destroyed, there seems to be little hope of collecting material of many forms. For the present, it appears reasonable to recognize three species in *Rhodacmea*.

The genus in North America undoubtedly represents a branch of the basic *Ancylus* stock, related to the European *Ancylus fluviatilis*, possibly through intermediate forms in the Old World and New World tropics.

Key to the Species of RHODACMEA

1 a. Shell more or less ribbed with strong radiating lines extending from the apex to the peritreme . . . . . *filosa*

b. Shell smooth, or nearly so 2

2 a. Shell moderately elevated, apex usually conspicuous in older specimens. Posterior slope straight or slightly concave; anterior slope straight or slightly convex ..... *hinkleyi*

b. Shell very elevated, apex usually eroded in older specimens. Posterior slope straight or slightly convex, anterior slope clearly convex... ..... *elatior*

Rhodacmea hinkleyi (Walker)

Ancylus (Ferrissia) hinkleyi Walker, 1908, Nautilus 21: 139, pl. ix, figs. 11-13, Ohio River at Golconda, Illinois.

Rhodacmea rhodacme Walker, 1917, Nautilus 31: 8, pl. I, figs. 1, 2, 8, Coosa River at Williamsville, Shelby County, Alabama.

Rhodacmea gwatkiniana Walker, 1917, Nautilus 31: 9, pl. I, figs. 3, 7, 9, Butting Ram Shoals, Coosa County, Alabama.

"*Ancylus rhodaceus* Walker," nomen nudum, Hinkley, 1906, Nautilus 20: 40.

Description: "Shell oval, slightly wider anteriorly, sides equally curved, elevated, conic; apex nearly central, being only slightly behind the longitudinal center and very slightly deflected toward the right, acute, erect, with strong radial striae; light greenish horn color with the apex bright rose color; anterior slope slightly convex, posterior slope slightly concave, lateral slopes of about the same slight convexity; surface smooth, lines of growth fine, but irregular, no trace of ribs or radial striae, except at the apex. Length 4.75, width 3.5, alt. 2.25mm." — Walker.

Types: hinkleyi, UMMZ 102649 H; *rhodacme*, UMMZ 102650 H, ANSP 91832, USNM 175999, MCZ 134018; *gwatkiniana*, UMMZ 102647 H.

Distribution: Present distribution is unknown; the species has not been collected within recent years to my knowledge. Early records indicate that this form was present in the Coosa River, Alabama, and the Tennessee River drainage, extending irregularly northward to the southern borders of Illinois and Indiana.

Ecology: On stones in fast water, or on shells of Pleuroceridae.

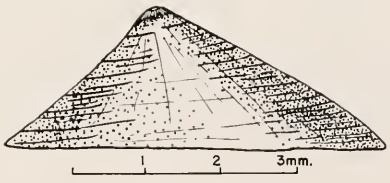

Fig. 4. *Rhodacmea hinkleyi*, type, UMMZ 102649. Pope County, Illinois.

Morphology: Unknown; radula typical for the genus.

Remarks: Shells of this species are relatively depressed, with the apex prominently raised over the contour of the shell. Specimens from the UMMZ listed under *R. hinkleyi*, *R. rhodacme*, and *R. gwatkiniana* appear to overlap in all characters rendering clear distinction impossible. Perhaps "*R. gwatkiniana*" is a juvenile of the species.

Rhodacmea filosa (Conrad)

Ancylus filosus Conrad, 1834, New fresh-water shells of the United States, p. 57, Black Warrior River, Alabama.

Rhodacmea filosa (Conrad). Walker, 1917, Nautilus 31: 6.

Description: "Shell regularly oval, rather elevated; with numerous radiating prominent lines; apex very prominent, inclined, eroded, not nearly central." — Conrad.

Types: Unknown.

Distribution: Black Warrior and Coosa rivers, and tributaries, Alabama. Some records also place this species in the Tennessee River system. I have never collected this form; perhaps it is now extinct.

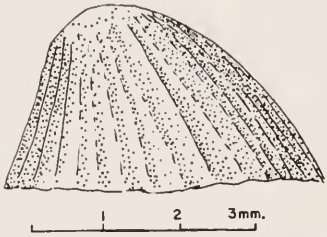

Fig. 5. *Rhodacmea filosa*, a typical specimen. AMNH 70556. Coosa River, Alabama. Note eroded apex.

Ecology: "It is abundant on various species of *Melania*," Conrad, 1834.

Morphology: Unknown; radula studied from dried specimens and typical for the genus.

Remarks: Rhodacmea filosa is distinguished mainly on the basis of prominent radial ribs appearing in some populations. It may be conspecific with *R. clatior*, but the shells are generally thinner and more delicate.

Rhodacmea elatior (Anthony)

Ancylus clatior Anthony, 1855, Ann. Lyc. Nat. Hist., New York 6: 158, pl. V, figs. 20-21, Green River, Kentucky.

Rhodacmea clatior (Anthony). Walker, 1917, Nautilus 31: 8.

Rhodacmea cahawbensis Walker, 1917, Nautilus 31: 7, pl. 1, figs. 4-6, Cahawba [Cahaba] River, Gurnee, Shelby County, Alabama.

Description: "Shell very much elevated, ovate; lines of growth distant, conspicuous; color light green, opaque; apex decuticated, recurved, sub-central; anterior and posterior slopes, convex; lateral slopes, plane; apical region rose-colored. Length, 0.26 inch (6½ mill.); breadth, 0.21 inch (5 mill.); height, 0.14 inch (3½ mill.)." —Anthony.

Types: clatior, AMNH 84991, AMNH 70571, MCZ 161851, 161852; *cahawbensis,* UMMZ 102635 II.

Distribution: Formerly in the Tennessee and Cahaba river systems. Now definitely known from the Cahaba, Alabama.

Ecology: On stones and naiad shells in swift current, together with *Ferrissia rivularis.*

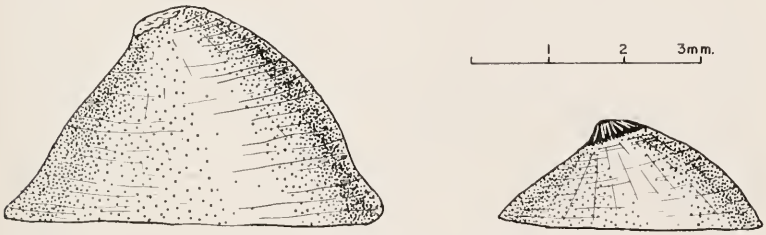

Fig. 6. *Rhodacmea clatior,* typical specimens. AMNH 70571. Kentucky (Anthony collection). Adult and juvenile.

Morphology: The anatomy of the soft parts has been described by Basch (1960) from specimens from the Cahaba River near Helena, Shelby County, Alabama. The penis is simple, without a flagellum. Radula as in the genus. The long radular sac, position of the anus on the pseudobranch, and the jaw all relate *Rhodacmea* to the Old World *Ancylus.*

Remarks: In two previous publications (Basch 1960, 1962a) I used the name *Rhodacmea cahawbensis* but on closer study I can see no way of separating *cahawbensis* and *clatior:* the older name in this case must be used for both.

Genus LAEVAPEX Walker, 1903

Type species. Ancylus fuscus Adams, 1841

This name was originally proposed by Walker as a "section" of *Ancylus*, intended to be equivalent to the section *Ferrissia*. The name was raised to generic rank in the incredible paper by Hannibal (1912), and the "genus" was distributed between two subfamilies, an entirely untenable situation. In Hannibal's paper, *Ferrissia* was made into a subgenus of *Laevapex*. In 1917, Walker reversed Hannibal's arrangement, commenting that it is ". . . absolutely futile and must be entirely disregarded." Thus, *Laevapex* was placed as a subgenus of *Ferrissia*, where it remained until the present author (Basch, 1959a), on the basis of anatomical characters, raised both groups to full generic rank. The radulae of *Ferrissia* and of *Laevapex* are extremely similar, possibly indicating a close relationship (Basch, 1962c), but the genitalia are quite different, and the shells, distribution, and habits of the groups are also distinct.

In 1903, Walker described the genus *Laevapex* as ". . . characteristic of the lakes and slow-flowing streams of the northern states, the Mississippi Valley and Florida. They are usually found on the reeds, dead leaves and submerged timber in such localities, and are rarely, if at all, found on stones, dead shells, etc., in rapidly flowing streams, where they are replaced by the species of the section *Ferrissia*." Recent records (see below) indicate that the genus is increasing its range westward.

I believe that *Laevapex* is a descendant of the tropical American genus *Hebetancylus*, having developed in an area such as the Florida peninsula through a major modification of the male genitalia (loss of the flagellum) and a minor change in the position of the shell apex. From Florida, *Laevapex* may have been distributed along the eastern coast of North America by migratory waterfowl using the Atlantic Flyway.

Key to the Species of LAEVAPEX

1 a. Shell ovate, smooth or with fine raised riblets usually on the anterior slope. Apex behind the center of the shell. In still water, typically in the backwater areas of rivers or in lakes; on vegetation or debris in the water ..... *fuscus*

b. Shell subcircular, smooth, often encrusted with dark material. Apex about in the middle of the shell. In slowly flowing streams, south-central and eastern states ..... *diaphanus*

Laevapex fuscus (C. B. Adams)

Ancylus fuscus Adams, 1841, Boston Jour. Nat. Hist. 3: 329, pl. III, fig. 17, Andover, Massachusetts.

Ancylus obscurus Haldeman, 1844, A monograph of the Limnaides and other fresh-water univalve shells of North America, no. 7, p. 9, pl. 1, fig. 5, Nolachucky River, Greeneville, Tennessee.

Ancylus cugraptus Pilsbry, 1896, Nautilus 9: 139, Illinois River at Havana, Illinois.

Ancylus peninsulae Pilsbry and Johnson, 1896, Nautilus 9: 138, St. John's River and other localities in Florida.

Ancylus kirklandi Walker, 1903, Nautilus 17: 29, pl. II, figs. 1-12, Grand River, Kent County, Michigan.

Ferrissia fusca (C. B. Adams). Walker, 1918, Miscel. Publ. Mus. Zool. Univ. Mich. 6: 120.

Ferrissia fusca cugrapta (Pilsbry). Walker, 1918, Miscel. Publ. Mus. Zool. Univ. Mich. 6: 120.

Ferrissia kirklandi (Walker). Walker, 1918, Miscel. Publ. Mus. Zool. Univ. Mich. 6: 120.

Ferrissia obscura (Haldeman). Walker, 1918, Miscel. Publ. Mus. Zool. Univ. Mich. 6: 120.

Ferrissia peninsulae (Pilsbry and Johnson). Walker, 1918, Miscel. Publ. Mus. Zool. Univ. Mich. 6: 121.

Ferrissia (Laevapex) obscura (Haldeman). Walker, 1920, Nautilus 33: 101.

Ferrissia (Laevapex) dalli Walker, 1920, Nautilus, 33: 102.

Description: "Shell thin, transparent without the epidermis, not much elevated, elliptical, moderately curved at the sides; epidermis brown, visible through the shell, giving it the appearance of having the same color, thick, rough, slightly extending beyond the margin of the shell; apex obtuse, moderately prominent, scarcely behind the middle, inclining to the right, so as to have only two-fifths of the width on that side. Length, 0.31 inch; width, 0.22 inch; height, 0.05 inch." —Adams.

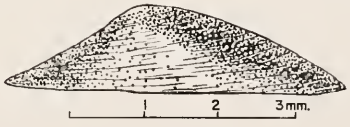

Fig. 7. *Laevapex fuscus*, a typical specimen. Pond at Sapelo Island, McIntosh County, Georgia.

The average dimensions of 25 specimens from the Huron River, Washtenaw County, Michigan, are: length, 5.34 mm., width, 3.75 mm., height, 1.72 mm., L/W, 1.425, and H/L, .322.

Types: fuscus, UMMZ 68054, MCZ 239452 Lectotype; *obscurus,* ANSP 21980 H; *eugraptus,* ANSP 68433 H; *peninsulae,* ANSP 69503 H, MCZ 59647; *kirklandi,* UMMZ 100542 H, ANSP 87164, USNM 573416, AMNH 44804, MCZ 140164, 150219, 150220, 88391; *dalli,* UMMZ 100388 H.

Distribution: United States and Canada, generally east of the Great Plains. Great Lakes area, Florida and southeastern states. Generally absent from mountainous areas. Shimek (1935) has reported the species in Iowa, Leonard (1959) from Kansas, and Branson (1961) from Oklahoma. The species may be moving westward.

Ecology: Commonly in impoundments or cut-off stagnant backwaters of rivers. The species is also found in lakes and occasionally in slow-flowing rivers on dense vegetation near the shores. The substrate is often debris such as cans, bottles, shoes, crockery, and other junk thrown into the water by thoughtless persons. *L. fuscus* is often found on the undersides of lily pads, on cat-tails, sedges, and other emergent rooted vegetation. Rarely, this species may be found together with *Ferrissia rivularis* when in a stream, or with *F. fragilis* when in a stagnant pool. In several collections sent by Mr. Fred Thompson from canals in Dade County, Florida, *Laevapex* and *Hebetancylus* are associated.

Morphology: Described in detail by Basch (1959a). The genitalia are sharply different from other freshwater limpets and distinguish *Laevapex* immediately. The radula is closely similar to that of *Ferrissia* and of *Hebetancylus.*

Remarks: This large limpet exists in many minor variant forms, particularly in the southeastern states. It is often extremely abundant where it occurs (for instance, Sapelo Island, McIntosh County, Georgia), but populations may easily be decimated by severe water pollution. The area in the Huron River at Ann Arbor, Michigan, from which many hundreds of specimens were taken from 1956 to 1959 yielded only two bedraggled specimens when examined in 1961. The river had become badly polluted. The species is susceptible to infestation by several different trematode parasites.

Laevapex diaphanus (Haldeman)

Ancylus diaphanus Haldeman, 1841, Monograph of the Limnaides or freshwater univalves of North America, no. 3, description on the cover, Ohio; Haldeman, 1844, redescribed in Monograph of the freshwater univalve Mollusca of the United States, no. 7, p. 8, pl. 1, fig. 4.

Ancylus hemisphaericus Walker, 1908, Nautilus 21: 140, pl. ix, figs. 14, 15, 16, Georgia and Decatur, Alabama.

Ferrissia hemisphaerica (Walker). Walker, 1918, Miscel. Publ. Mus. Zool. Univ. Mich. 6: 120.

Ferrissia diaphana (Haldeman). Walker, 1918, Miscel. Publ. Mus. Zool. Univ. Mich. 6: 120.

Description: "Shell thin in texture, diaphanous, very wide, nearly circular, depressed; apex obtuse, almost central: slope scarcely convex. Color very pale olivaceous, translucent, aperture white. Dimensions. Long. 5.5, lat. 4.5, elev. 2 millim. Geographical distribution. Discovered in Ohio, by Mr. Anthony. Observations: Distinguished by its circular and flattened form; and central, inconspicuous apex." —Haldeman, 1844.

I have collected this form only in central Arkansas. Eleven adult specimens collected in July in the South Fourche River, Perry County, have the folowing dimensions:

Average length, 5.49 mm.
Average width, 4.41 mm.
Average height, 1.50 mm.
Average L/W, 1.24
Average H/L, .273.

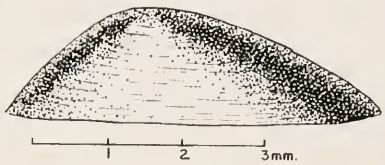

FIG. 8. *Lacvapex diaphanus*, a typical specimen. South Fourche River, Perry County, Arkansas.

Types: diaphanus, ANSP 21978; *hemisphaericus*, UMMZ 100506 H, ANSP 94671, MCZ 140166.

Distribution: Delaware, Ohio, Illinois, Tennessee, and Holston rivers (Walker, 1903), also Georgia and Alabama. Owing to extensive changes in all of these rivers in the past sixty years, the range may now be much smaller. I have collected in the Delaware, Ohio, Tennessee, and Holston rivers, and have not found the species there. Where I have found it, specimens have occurred on smooth stones two or more inches in diameter near the banks of shallow, slowly flowing streams.

Morphology: Similar in all respects, including the radula and genitalia, to *Lacvapex fuscus*. Many specimens have a tendency

to lose the pigment core of the tentacles, although it is present in some members of the population. The animal is relatively wider than that of *L. fuscus*.

Remarks: Until quite recently, I have considered *diaphanus* and *hemisphaericus* to be distinct species, and reported the Arkansas material as *hemisphaericus* (Basch, 1962c). A re-examination of the specimens, together with careful measurements, has convinced me that these are all one species. Perhaps the Georgia specimens upon which Walker based *hemisphaericus* were juvenile, or small for some other reason.

Genus HEBETANCYLUS Pilsbry, 1913

Type species. Ancylus moricandi d'Orbigny, 1836

In a footnote, Pilsbry (1913) named three genera for South American Ancylidae that did not belong to any of the groups established for northern species. The genus *Hebetancylus* was further clarified by Pilsbry (1924) to include ". . . large, low ancylids with the apex blunt, smooth, distinctly on the right of the median line and moderately posterior . . ." Such shells had been reported from Texas by Pilsbry (1889), Walker (1903), and others, but their generic placement and anatomical details have been in doubt. I have received a large number of preserved animals belonging to this genus, collected by Mr. Fred G. Thompson of the University of Miami, and they are of great importance in clarifying the relationships of American ancylids. These specimens appear to belong to the following species:

HEBETANCYCLUS EXCENTRICUS (Morelet)

Ancylus excentricus Morelet, 1851, Test. Noviss. insul. Cuba. et Amer. Centr., Pars II: 17, Lake Peten, Guatemala.

Ferrissia excentrica (Morelet). Walker, 1918, Miscel. Publ. Mus. Zool. Univ. Mich. 6: 120.

Description: Shell depressed, widely ovate, diaphanous: apex blunt, smooth, clearly on the right side of the median line. Concentric growth lines fairly prominent, radial lines barely perceptible on anterior slope of shell.

Dimensions of 50 specimens
(collected March, 1962, Dade County, Florida)

Average length	4.16 mm.
Range, length	2.15 to 5.84 mm.

S. D., length	0.78 mm.
Average width	2.75 mm.
Range, width	1.65 to 3.94 mm.
Average height	1.58 mm.
Range, height	0.89 to 2.03 mm.
Average L/W	1.51
Average H/L	.380

Distribution: Living animals occur in large numbers in canals in Dade County, Florida. Specimens have been sent to me from canals near Tamiami Trail (U. S. Highway 41) at Palmetto Bypass and from ½ mile west of Coopertown. I have collected a few specimens from a roadside ditch on Sapelo Island, McIntosh County, Georgia, and it is probable that the species will be found on other coastal islands. According to Walker (1903), specimens of this type were reported from Travis County, Texas. I have checked some of this material (ANSP 60132), and also shells from Hays, Kerr, Jackson, Victoria, and Mason counties, Texas, and find no great differences from the Florida specimens.

Similar specimens, under a variety of names, were examined from the following localities: *Mexico:* Lake Patzcuaro; Lake La Prassa, Michoacan; Lake Xochomilco; Coy R., S. Luis Potosi. *Nicaragua:* San Geronimo; Polvon. *Guatemala:* Quirigua; Tikal. *British Honduras:* Rio Hondo. Other specimens from Guadeloupe, W. I., Cuba, St. Croix, V. I., and Vieques Island (Puerto Rico) indicate a general Caribbean distribution, with entries into North America through Texas and Florida.

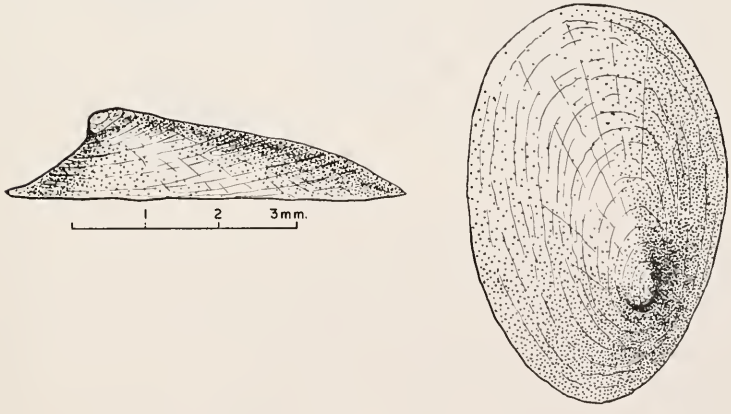

Fig. 9. *Hebetancylus excentricus,* large specimen. Canal near Miami, Dade County, Florida.

Ecology: According to Mr. Thompson (personal communication): ". . . I collected a few thousand limpets of the excentric-apex type from the canal near the intersection of the Palmetto Bypass and the Tamiami Trail (U. S. 41). It is very easy to collect them at this point. The canal forms a large pond at this point, and is deep. The limpets are characteristically found on the underside of boards and dead wood, and on some pieces that lie on the bottom of the canal, they may actually completely cover portions of the wood (areas up to ten inches in diameter)." The specimens collected by the author on Sapelo Island, Georgia, were found on sticks in a shallow roadside ditch.

Morphology: The reproductive anatomy of this species is illustrated on Figure 10. The radula is extremely similar to that of *Ferrissia* and *Laevapex*, although the central tooth is typically asymmetrical. The general features of the radula are common to those of many planorbid snails and are of little use in generic distinction. In its outward appearance the animal resembles that of *Laevapex*, particularly in the peculiarly folded two-lobed pseudobranch. The two genera may be easily distinguished by the dark pigment core in the tentacles of *Laevapex*, absent in *Hebetancylus*. Central nervous systems are practically identical; the intestine of *Hebetancylus* seems proportionately wider than that of *Laevapex*. The reproductive system is particularly interesting, since in several respects it is intermediate between that of *Ferrissia* and *Laevapex*. The seminal vesicle is an expanded, twisted dilation of the hermaphroditic duct, resembling *Ferrissia* in this respect. The prostate consists of about four digitiform lobules, occasionally folded over themselves in the manner of *Laevapex*, but proportionately far smaller. The penis is uniformly flagellated, although it is an ultra-penis, thus sharing the former feature with *Ferrissia*, and the latter with *Laevapex*. There is no pigment on the preputium as found in *Laevapex*.

Remarks: Hebetancylus excentricus (Morelet) is used here as the most probable name for this species. It is possible that *excentricus* is a synonym of the earlier *radiatus* Guilding, 1827, but I have not seen any of Guilding's specimens and find his description too vague to use alone. A complete synonymy of this species would necessitate considerable reference to the literature of tropical American mollusks, and is beyond the scope of the present paper. Walker (1903) thought this species to be a *Laevapex*.

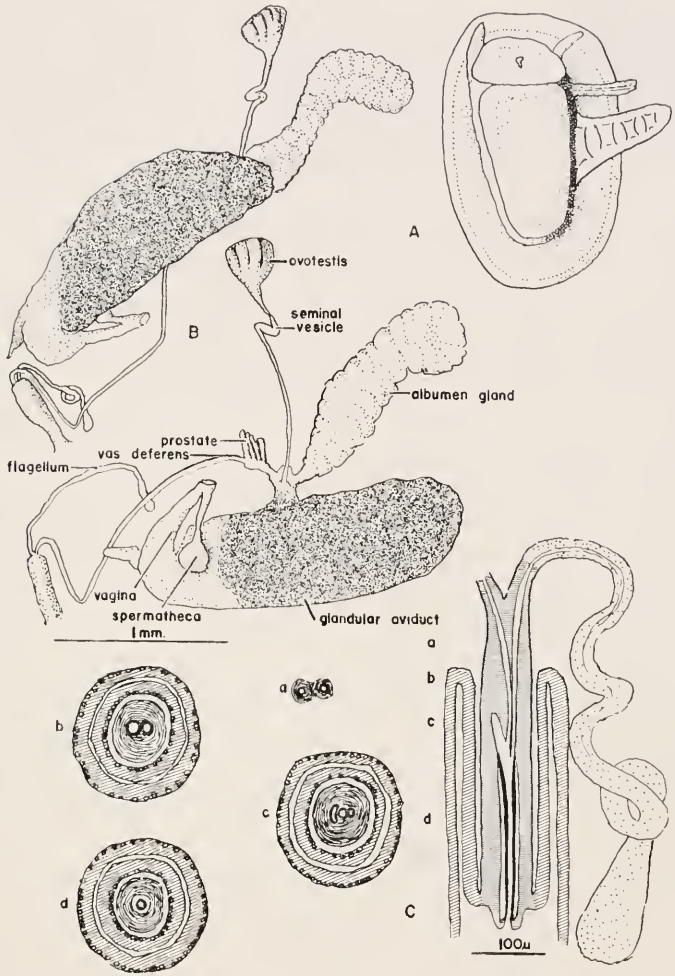

FIG. 10. Reproductive system of *Hebetancylus excentricus*. A, animal with male genitalia extended; B, entire reproductive system, dissected from a mature specimen, as viewed from the left side, and with the organs separated. The albumen gland is a glassy white color, and the glandular oviduct when well developed is bright yellow. Other organs are whitish. The 1 mm. scale refers to B only; C, male genitalia, as reconstructed from whole mounts and serial sections: a, b, c, d on the sagittal section are levels of the corresponding cross sections illustrated.

It is likely that mollusks similar to this have given rise to *Laevapex*, possibly in southern Florida.

In a recent letter, Dr. Bengt Hubendick has informed me that he has been studying the anatomy of a species of *Hebetancylus* and has also found the flagellated ultra-penis arrangement. Thus the credit for first recognizing this feature should be his.

Genus FERRISSIA Walker, 1903

Type species. Ancylus rivularis Say, 1817

This genus is by far the largest and most complex of all the freshwater limpets, and may be the most widespread of any freshwater gastropod. Species of *Ferrissia* are known from North and Central America (Wurtz, 1951), Africa (Walker, 1923; Pilsbry and Bequaert, 1927), and Asia (Preston, 1915; van Benthem Jutting, 1956). In recent years *Ferrissia* has been found in Europe (Boettger, 1949; Jaeckel, 1954). The relationships between *Ferrissia* and other ancylid genera such as *Anisancylus*, *Burnupia*, and *Uncancylus* are still obscure, owing to the scarcity of comparative anatomical information.

In North America more than two dozen names have been included in *Ferrissia*, but I feel that the actual number of species is far smaller. Ecological phenotypes are numerous, and the plasticity of shell form has been remarked upon many times.

The "typical" and most widely distributed *Ferrissia* is *F. rivularis*, of which I have collected practically identical specimens from Colorado and Wyoming to the eastern seaboard. The

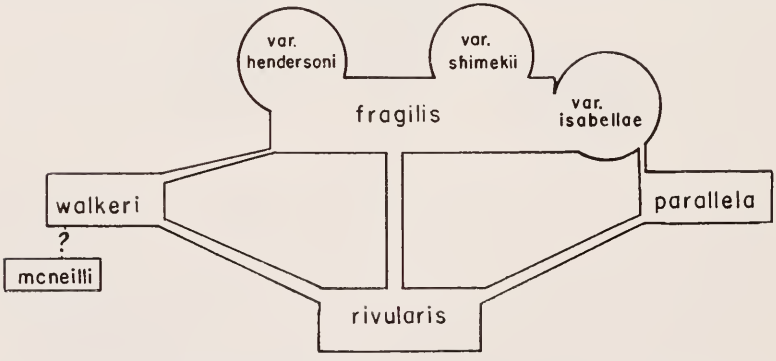

FIG. 11. Species of North American *Ferrissia*. Connections between the boxes representing species indicate the presence of shells intermediate in shape. This should not be interpreted as a phylogenetic scheme.

species seems to be characteristic of smaller rivers of which the following are typical: Wyoming: Little Laramie River, Albany County; Colorado: Boulder Creek, Boulder County; Kansas: Neosho River, Lyon County; Michigan: Raisin River, Lenawee County; Tennessee: Nolichucky River, Greene County; Pennsylvania: Juniata River, Blair County; Virginia: Battery Creek, Bedford County.

In many areas the typical *rivularis* form appears to be absent or quite strongly modified. One common modification is stunting. I have collected in many localities in California, Idaho, Ohio, Virginia, Mississippi, and other states where the animals resemble *F. rivularis*, but are much smaller. The size groups are distributed irregularly, and I have not found it possible to account for size differences by use of any simple ecological or geographical factors.

In standing waters with rooted emergent vegetation, it is very common to find specimens of *Ferrissia*. Such rheophobic species are difficult to analyze, but it is possible to state some general principles. First, the larger specimens are generally found farther north. There is no simple regression relationship correlated with temperature, for tiny septate or non-septate specimens have also been found in the North (Basch, 1960), but these are far more abundant in southern states. The ecological place of the large northern *Ferrissia parallela* is replaced in the South by species of *Laevapex* of approximately the same size (*Laevapex* occurs in the North also). In the northwestern corner of the United States one finds neither *F. parallela* nor the tiny *F. fragilis* in typical form, but rather a form appearing to be intermediate between the two. This latter type is here called *Ferrissia fragilis* var. *isabellae*. Figure 16 shows the major types of *Ferrissia* found in the United States. I have found no way to separate species unequivocally, and believe that they may all represent different directions of clinal variations within one large "super-species."

The genus is characterized by the possession of a club-shaped flagellum on the otherwise simple penis. The duct of this flagellum in all specimens studied enters the side of the penis sheath, as described by Hoff (1940), not into the lumen of the penis as Baker (1928) incorrectly indicated. Smaller specimens of *F. fragilis* are often aphallate, and this situation is also known among the larger *Ferrissia*. The radial striae on the apex, representing the portion of the shell present within the egg capsule,

are characteristic of the genus, but these delicate markings are easily eroded and often lost in larger specimens.

It has been the recent custom to assume that any freshwater limpet is "a *Ferrissia*." In the central United States this is usually true, but one must be careful to distinguish *Lanx* in the Northwest and *Laevapex* and *Hebetancylus* in the East.

Key to Species of FERRISSIA[1]

1 a. Shell thin, fragile, very much depressed (elevation .25 or less), often a glossy red-brown color. Apex fairly prominent as a rounded bump in the right posterior quadrant. Length of shell to about 5 mm. In streams, southern Alabama ..... *meneilli*

b. Shell not as above, usually more elevated, color variable from straw-yellow to dark gray. Apex prominent to obtuse, in the midline or to the right. Length from 2 to 10 mm. In various habitats, widely distributed 2

2 a. Shell robust, to 7 mm. long, elevated, aperture elliptical, spread from 1.4 to 1.7. Apex in midline or slightly to the right; anterior slope convex, posterior slope gently concave, lateral slopes approximately straight. Calcareous material often thick inside the shell. Many populations are smaller, especially those west of the Rocky Mountains. In rivers and streams, widely distributed ..... *rivularis*

b. Shell not as above; habitat in standing water 3

3 a. Shell large, elevated, very narrow (spread 1.8 or more), length to 9 mm. Apex obtuse, in the midline; posterior slope flat or gently concave; lateral slopes straight or faintly concave. Peritreme often arched. On vegetation in lakes, Canada and adjacent states ..... *parallela*

b. Shell in standing water, but not as above 4

4 a. Shell depressed or moderately elevated, less than 4 mm. long, rarely exceeding 3.5 mm., with or without a shelf-like septum across the posterior part of the aperture. When non-septate, the aperture is distinctly oval, wider anteriorly. When septate, the shell is evenly elliptical. Secondary growth may be present. Habitat in ditches and other small bodies of standing water, often temporary, and usually stagnant. Widely distributed ..... *fragilis*

b. Shell to 6 mm. long, usually depressed; peritreme clearly oval, wider anteriorly, septum never present. Apex subacute, often far in the right posterior quadrant. Anterior and left slopes convex, posterior and right slopes concave. On vegetation and debris in ponds, widely distributed ..... *walkeri*

[1] This key is based upon adult specimens. Owing to individual variations in many populations, the user should select from the population to be identified a few large, typical specimens and check them against the characters mentioned in the key. Where only one or a few shells of doubtful maturity are available, accurate identifications may not be possible.

Ferrissia rivularis (Say)

Ancylus rivularis Say, 1817, Jour. Acad. Nat. Sci. Phila. 1: 125, Delaware and Susquehanna rivers, Pennsylvania.

Ancylus tardus Say, 1830, New Harmony Disseminator of Useful Knowledge, p. 26, Wabash River, Indiana.

Ancylus calcarius DeKay, 1843, Zoology of New York. Part V. Mollusca, p. 13, pl. 5, fig. 99, Passaic River, near Paterson, New Jersey.

Ancylus depressus Haldeman, 1844, A monograph of the freshwater univalve Mollusca of the United States, no. 7, p. 6, pl. 1, fig. 2, Holston River, Virginia; non *Ancylus depressus* Deshayes, 1824; non *Ancylus depressus* Keferstein, 1834.

Ancylus haldemani Bourguignat, 1853, Cat. ancycles *in* Jour. Conch., 4: 180; 1853, Proc. Zool. Soc. London, p. 83.

Ancylus ovalis Morse, 1864, Journal of the Portland Society of Natural History 1: 44, figs. 101, 102, Androscoggin River at Bethel, Maine.

Ancylus borealis Morse, 1864, Journal of the Portland Society of Natural History 1: 45, figs. 103, 104, Patten, Maine.

Ancylus caurinus Cooper, 1873, Proc. Calif. Acad. Sci. 4: 100.

Ancylus oregonensis Clessin, 1882, Systematisches Conchylien-Cabinet Bd. I, Abt. 6: 66, pl. 8, fig. 1, Salem, Oregon.

Laevapex (*Ferrissia*) *caurinus* (W. Cooper). Hannibal, 1912, Proc. Malac. Soc. London 10: 150.

Ferrissia haldemani (Bourguignat). Walker, 1918, Miscel. Publ. Mus. Zool. Univ. Mich. 6: 119.

Ferrissia tardus (Say). Walker, 1918, Miscel. Publ. Mus. Zool. Univ. Mich. 6: 120.

Ferrissia rivularis (Say). Walker, 1918, Miscel. Publ. Mus. Zool. Univ. Mich. 6: 119.

Ferrissia ovalis (Morse). Walker, 1918, Miscel. Publ. Mus. Zool. Univ. Mich. 6: 119.

Ferrissia browni Walker, 1925, Occ. Pap. Mus. Zool. Univ. Mich. 165: 4, pl. I, figs. 5, 6, White River, south of Elkins, Arkansas, Washington County.

Ferrissia arkansasensis Walker, 1925, Occ. Pap. Mus. Zool. Univ. Mich. 165: 5, pl. I, figs. 7, 8, main fork of White River, south of Elkins, Arkansas.

Description: "Shell corneous, opake, conic-depressed, apex obtuse, nearer to and leaning towards, one side and one end; aperture oval, rather narrower at one end, entire; within milk-white. Length ¼ inch." — Say.

Types: rivularis, ANSP 21982 H; *tardus*, ANSP 58045 H; *calcarius*, unknown; *depressus*, ANSP 21999 H; *borealis*, unknown; *ovalis*, unknown; *caurinus*, USNM 9098; *oregonensis*, unknown; *browni*, UMMZ 100330 H, ANSP 160565, UMMZ 69587, MCZ 50504, 67605; *arkansasensis*, UMMZ 100300, ANSP 160566, UMMZ 100321, MCZ 50503, 67606.

Distribution: It is difficult to determine the distribution of this species from published records because of the frequency with which the name has been misapplied. Typical specimens are known from the east coast to the Rockies, but apparently in the southern and western states the specimens are characteristically smaller. The difficulty of distinguishing good species from local variants has been mentioned several times in this paper; with regard to *F. rivularis* I must say that in my own field collections and in museum lots I have found many atypical populations, particularly of small individuals, but these populations do not seem to be distributed in any coherent fashion. Perhaps the season of collection and the geology of the river basin are significant in explaining the variations found in collections from streams in all parts of the United States. The species does not occur in the swampy lowlands of the Southeast.

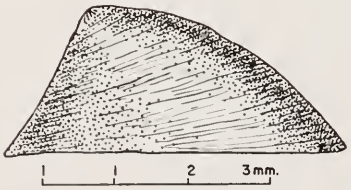

FIG. 12. *Ferrissia rivularis*, a typical specimen. Neosho River, Lyon County, Kansas.

Ecology: The usual habitat of *F. rivularis* is a stream with a gravelly bottom, containing a large proportion of stones at least two inches in diameter. Occasional good collections have been taken from earthy silt-laden streams with muddy bottoms (Neosho River, Kansas, in the spring), but where the silt is finely divided clay that remains in suspension, limpets are invariably absent. *Ferrissia rivularis* is tolerant of organic pollution. One of the best collecting localities I have found is in the Rocky River at Cedar Falls, North Carolina, a spot where the river smells of decaying matter. Whether because of agricultural chemicals, silting, or other factors, many streams I have examined in Iowa and northern Illinois are entirely devoid of ancylids and of most other forms of life.

Figure 13 shows the distribution of shell lengths in five typical populations of *Ferrissia rivularis*. In two of these (Pennsylvania and Virginia), the young of the year at this time form a

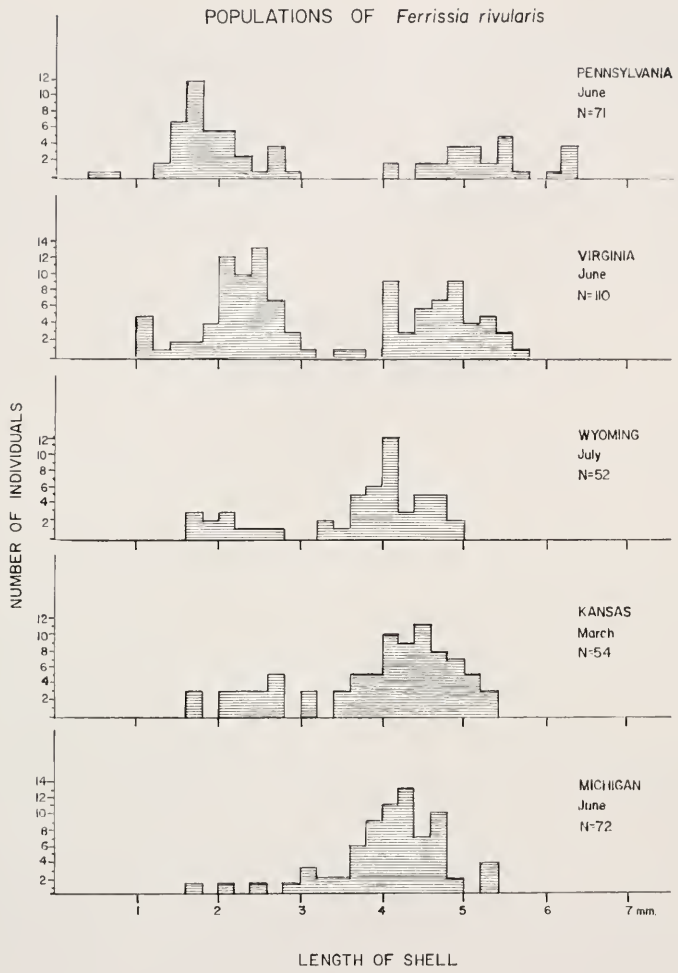

FIG. 13. Populations of *Ferrissia rivularis*. Specimens of less than 3 mm. shell length are considered young of the year; those larger are adults. N = number of individuals in the population measured.

Pennsylvania: Westmoreland County, 1 mi. NE New Florence, June 17, 1961; Virginia: Bedford County, Battery Creek 1 mi. N Big Island, June 24, 1961; Wyoming: Albany County, Little Laramie River at U. S. 130, July 26, 1961; Kansas: Lyon County, Neosho River 1 mi. NE Emporia, March, 1961; Michigan: Kalamazoo County, 2½ mi. N Augusta, June 8, 1961.

considerable proportion of the population, while in the other three only a few young are present. These data and other observations suggest a simple annual cycle, with individuals living from spring or summer until autumn of the following year. It is interesting to note that in these five populations the size range of the specimens is almost identical. Although lots containing larger specimens were admittedly selected for measurement, a real attempt was made to collect and measure a true sample of these populations including all sizes in their actual proportions as they occur in nature.

The size of the limpets does not seem to be correlated with the size of the stream in which they live, for I have often collected large, robust specimens from a brook small enough to jump across. Large rivers, 100 feet or more across, are generally unproductive unless there are extensive, shallow, shoaly areas. Usually such rivers are too deep for hand collecting, and the banks at workable depths are often heavily covered with mud. Rivers of navigable size are almost all dammed, dredged, or otherwise altered, and it is often difficult to approach the water from modern highways and bridges without long hikes across private property.

Morphology: Described by Hoff (1940). The short, blunt flagellum is quite characteristic of the genus.

Remarks: This species has been the subject of a great deal of confusion for over a century. In particular, the distinction between *rivularis* and *tarda* has never been clear. In museum material, I have been unable to find any perceptible differences between lots of specimens preserved under each of these two names. I believe it best to consider all of these river limpets under the single species *rivularis*. *Ferrissia arkansasensis* and *F. browni* appear to be stunted variants of this form, or perhaps may represent incipient subspecies developing in the rather isolated drainages of the state of Arkansas. They are placed here with hesitation.

Ferrissia mcneilli Walker

Ferrissia (sensu stricto) mcneilli Walker, 1925, Occ. Pap. Mus. Zool. Univ. Mich. 165: 2, pl. I, figs. 3-4, Mandeville Creek, Mobile County, Alabama.

Description: "Shell depressed, oval, slightly wider anteriorly; light horn color; anterior margin regularly rounded; posterior margin obliquely truncate as it passes into right margin; lateral margins about equally curved, the right slightly more than the

left; anterior slope nearly straight, slightly curved as it approaches the apex; posterior slope straight from the base of the apex to the posterior margin; right lateral slope incurved, the left one slightly convex; apex prominent, subacute, somewhat obtuse, eccentric, situated at about $\frac{2}{3}$ of the length from the posterior margin and $\frac{1}{3}$ of the distance from the median line to the right margin, radially striate; surface with irregular growth-lines and distinctly radially striate on the anterior and lateral slopes, but only obsoletely on the posterior slope. Length 5, width 3.3, alt. 1 mm.'' — Walker.

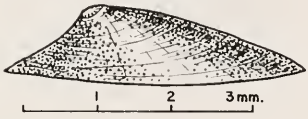

FIG. 14. *Ferrissia mcneilli*, a typical specimen. UMMZ 100549. Mobile County, Alabama.

Type: mcneilli, UMMZ 100549.

Distribution: Known to me only from Alabama specimens. The UMMZ has a lot of questionable specimens from ''Florida.'' Authentic material is all from the Mobile area, where I have never collected.

Ecology: Unknown.

Morphology: Unknown.

Remarks: It is possible that this is an exotic tropical form introduced accidentally into the southern part of Alabama.

FERRISSIA WALKERI (Pilsbry and Ferriss)

Aneylus walkeri Pilsbry and Ferriss, 1906, Proc. Acad. Nat. Sci. Phila. 1906: 564, pls. xx, xxi, xxii, fig. 5, Arkansas, Rogers, Benton County.

Ferrissia walkeri (Pilsbry and Ferriss). Walker, 1918, Miscel. Publ. Mus. Zool. Univ. Mich. 6: 120.

Ferrissia michiganensis Winslow, 1923, Occ. Pap. Mus. Zool. Univ. Mich. 145: 2, pl. I, figs. 6, 7, 8, Willow Brook, west of Harbert, Chickaming Township, Berrien County, Michigan.

Ferrissia bayacalifornica Walker, 1924, J. Washington Acad. Sci. 14: 431, fig. 1, small pool two and one-half miles inland from San Jose del Cabo, Lower California.

Ferrissia occidentalis Walker, 1924, J. Washington Acad. Sci. 14: 431, fig. 2, small pool two and one-half miles inland from San Jose del Cabo, Lower California.

Description: "Shell pale corneous, thin, oval, the right and left sides equally curved; moderately elevated, the apex depressed, radially striate, situated behind the posterior third, and much nearer the right than the left margin. Surface densely and minutely striate concentrically, and showing faint traces of radial striae. Anterior and left slopes convex; right and posterior slopes concave. Length 4.3, width 2.75, alt., 1.4 mm." — Pilsbry and Ferriss.

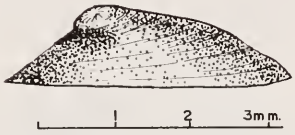

FIG. 15. *Ferrissia walkeri*, a typical specimen. ANSP 87479. Benton County, Arkansas.

Types: walkeri, ANSP 87479 H, UMMZ 101987; *michiganensis*, UMMZ 13057 H; *bayacalifornica*, USNM 264600 H, USNM 361554, UMMZ 100328; *occidentalis*, USNM 361553 H, USNM 361555, UMMZ 100561.

Distribution: This form is limited to ponds and lakes, and is dependent more upon suitable habitats than upon geographical areas for its distribution. The names above that I consider synonymous are of specimens from Arkansas, Michigan, and southern California. The actual range of the form is unknown.

Ecology: On lily pads and other large flat surfaces in clean standing water.

Morphology: As far as is known, similar to *F. rivularis*.

Remarks: Of the standing-water *Ferrissia* there are innumerable intergrading forms, the larger of which I have specified as *F. walkeri*. Between this species and *F. fragilis* we find a continuous gradient, but the ends of the series are so different that I find it inconsistent to apply the same specific name to specimens varying in size by a factor of two and three times. Larger limpets of this type are characteristic of larger bodies of standing water, while the typical *fragilis* form is found in most cases in smaller ponds and ditches where the water is more turbid and more highly charged with organic matter. The species may be distinguished from *Hebetancyclus excentricus* by its apical striations (and reproductive system). *Ferrissia walkeri* may be a descendant of the *F. rivularis* type, having moved from streams to ponds in southern areas in a manner similar to *F. parallela* farther north.

Ferrissia fragilis (Tryon)

Ancylus fragilis Tryon, 1863, Proc. Acad. Nat. Sci. Phila. p. 149, pl. 1, fig. 15. Laguna Honda, California.

Gundlachia meekiana Stimpson, 1863, Proc. Boston Soc. Nat. Hist. 9: 250, figs. 2, 3, between Georgetown and the Little Falls, and the canal and the Potomac River.

Gundlachia californica Rowell, 1863, Proc. Calif. Acad. Sci. 3: 21, Feather River to Mereed River, west to coast.

Gundlachia stimpsoniana Smith and Prime, 1870, Ann. Lyc. Nat. Hist. New York 9: 399.

Ancylus obliquus Shimek, 1890, Bull. Lab. Nat. Hist. State Univ. Iowa 1: 214, Deadman's Run, Lincoln, Nebraska.

Ancylus shimekii Pilsbry, 1890, Nautilus 4: 48.

Ancylus pumilus Sterki, 1902, Eighth Annual Report, Ohio Acad. Sci., p. 7.

Ancylus (*Ferrissia*) *hendersoni* Walker, 1908, Nautilus 21: 138, pl. ix, figs. 1-10, Lake Waccamaw, North Carolina.

Ancylus (*Ferrissia*) *novangliae* Walker, 1908, Nautilus 21: 138, pl. ix, figs. 5, 6, 7, Cambridge, Massachusetts.

Gundlachia (*Kincaidilla*) *fragilis* (Tryon). Hannibal, 1912, Proc. Malacol. Soc. London 10: 148.

Ferrissia fragilis (Tryon). Walker, 1918, Miscel. Publ. Mus. Zool. Univ. Mich. 6: 119.

Ferrissia hendersoni (Walker). Walker, 1918, *loc. cit.*

Ferrissia novangliae (Walker). Walker, 1918, *loc. cit.*

Ferrissia pumila (Sterki). Walker, 1918, *loc. cit.*

Ferrissia shimekii (Pilsbry). Walker, 1918, *loc. cit.*

Ferrissia bartschi Walker, 1920, Proc. U. S. National Mus. 57: 525, fig. 1, Lake Maxinkuckee, Indiana.

Ferrissia meekiana (Stimpson). Hibbard and Taylor, 1960, Contr. Mus. Paleontol. Univ. Mich. 16: 113.

Description: "Shell very small and fragile, sides nearly parallel or slightly incurved in the middle, but diverging anteriorly; ends rounded. Apex elevated, acute, curved backwards, with about two-thirds of the shell anterior to it.

Dimensions: "Size of the largest specimen. Length 4 mill., breadth 1.15 mill., height 1 mill. Most of the specimens do not exceed two-thirds of these dimensions. . . . This species is smaller, thinner, and wants the convex lateral margins of our *Anc. rivularis*, Say. It agrees with that shell, however, in the greater width of its anterior end, while in the shape of its lateral margins it resembles *Anc. parallelus*, Hald. It is much the smallest of our species."— Tryon. Figures 17 and 18 show dimensions of populations of this species.

Types: fragilis, ANSP 22011 H, USNM 169956; *meekiana*, ANSP 21969; *californica*, UMMZ 102011; *stimpsoniana*, ANSP

134988 II; *pumilus*, unknown; *novangliae*, UMMZ 100557 II, UMMZ 69604, 100558, ANSP 94670, MCZ 134138, 164776; *bartschi*, USNM 334709, USNM 334709a, UMMZ 100327; *obliquus*, UMMZ 101903; *hendersoni*, unknown.

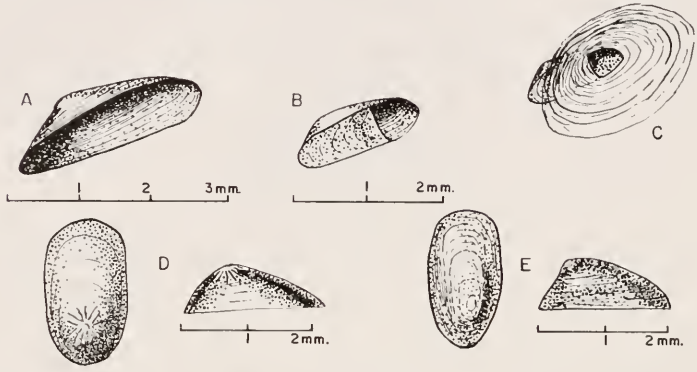

FIG. 16. *Ferrissia fragilis*. A, non-septate, B, septate, C, post-septate specimens from Stafford County, Kansas; D, *F. fragilis* var. *hendersoni*, Bladen County, North Carolina; E, *F. fragilis* var. *shimekii*, Lancaster County, Nebraska. *F. fragilis* var. *isabellae* resembles A in form but is slightly larger.

Distribution: Ferrissia fragilis appears to be among the most widely distributed of North America freshwater snails. It is found in all areas I have studied where suitable habitats appear. The septate form is known from California (Rowell, 1863), Texas (Clapp, 1913), New York (Smith and Prime, 1870; Cooke, 1882), Michigan (Basch, 1959c), and many other areas.

Ecology: These snails often may be found on the bottom inch of stems of *Typha* and other rooted flowering plants growing in ditches and swamps, as well as on sticks, bottles, and other trash. The water in which they live is often dark and foul-smelling, and the habitats usually have a mud bottom. One often finds leeches, sphaeriid clams, and small planorbid snails such as *Gyraulus* and *Menetus* associated with these limpets. As mentioned previously, there is a continuous gradient of forms between typical *fragilis* and typical *walkeri*, apparently conditioned by the size of the water body and the cleanliness of the water itself. Septate forms are known from two principal types of habitat, temporary woods pools such as those found in the

northern states, and roadside ditches from which the water presumably disappears for part of the year. In Stafford County, Kansas, I found an enormous population consisting of many thousands of septate specimens concentrated in a shallow drying pond in a field near an area of sand dunes. Vegetation in the

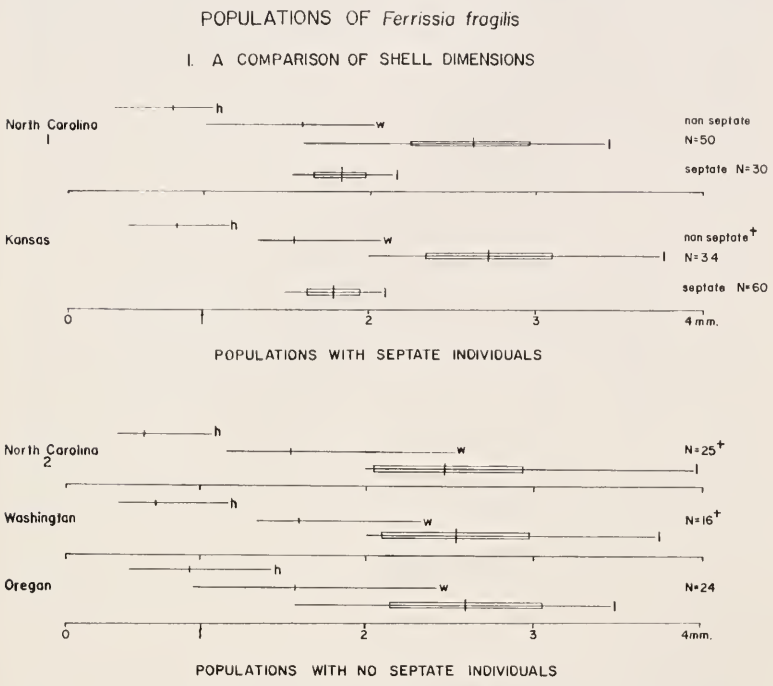

FIG. 17. Comparison of shell dimensions of five populations of *Ferrissia fragilis*. h = height; w = width; l = length; N = number of specimens in the group measured; horizontal line indicates range, cross line indicates mean, box indicates 1 standard deviation. Two of these populations included septate individuals; the other three did not. Note that septate specimens rarely exceed two millimeters in length. In populations marked with a +, only those non-septate individuals 2 mm. or longer were measured, in order to eliminate those smaller animals which might later have become septate. Such selection does not alter means greatly.

North Carolina 1: Gates County, marsh 4½ mi. SW Sunbury, June 25, 1961; Kansas: Stafford County, pond near sand dunes, August 18, 1960; North Carolina 2: Washington County, ditch 15 mi. SE Plymouth, June 25, 1961; Washington: Kittitas County, ditch 2 mi. NE Ellensburg, July 31, 1961; Oregon: Lane County, irrigation ditch at Veneta, August 4, 1961.

pond consisted of cattails and sedges, and the snails were living upon these in a few inches of water. I have never seen a population consisting only of septate individuals, and the non-septate ones are indistinguishable from specimens in other populations in which septum formation does not occur. Hence, I must treat all of these forms as a single species. Figures 17 and 18 show a comparison of shell dimensions and proportions of individuals from five populations.

Morphology: In all essential characters, the anatomy of *F. fragilis* resembles that of other species of *Ferrissia*. The size of the flagellum is quite variable in the specimens I have dissected, ranging from a small stump to a large gland the size of the preputium, but this character does not seem to be uniform in the populations studied. The size of the flagellum, and indeed of the entire penial complex is more closely associated with the reproductive condition of the particular individual studied than with other population characteristics. In many of the populations studied, the septate specimens were aphallate, a situation also described in the well-illustrated paper by Mirolli (1960) for the Italian specimens he calls *Watsonula wauteri*. The status of the septate ancylids was discussed by me in a previous paper (Basch, 1959c), and I feel now that there is no reasonable basis for placing the North American septate forms in a separate genus (*Gundlachia*).

Remarks: These highly plastic shells are difficult to identify with precision. I believe that the best disposition of the group at present is to consider all populations as ecophenotypes of a single species.

Three local variants appear to be sufficiently distinct to warrant recognition, although I believe that any species designation would presently be premature. The first of these I would call *Ferrissia fragilis* var. *hendersoni*, intending here to include the same group as in Walker's *F. hendersoni*. The variety is recognizably different from other populations of *F. fragilis* in its dome-like evenly rounded obtuse apex, clearly marked with radial striae. Occasional specimens of other populations, particularly in the southeastern states, might be assigned to this variety if seen alone. The original type locality of the form, Lake Waccamaw, Columbus County, North Carolina, has recently been partly developed as a resort area, and I was not able to find any typical specimens there. However, I did locate an excellent population in Singletary Lake, in adjacent Bladen

County. The form appears to be a local variant, perhaps developed as a result of genetic drift in a circumscribed area.

The second recognizable form is not so clearly defined as is var. *hendersoni*. This is *Ferrissia fragilis* var. *shimekii*, and differs from the typical *fragilis* in its concave lateral slopes. Such a "pinched-in" appearance has been found in several populations, particularly from the north-central area, but I am not certain whether the growth form indicates a genetic or an ecological difference from other populations of *F. fragilis*.

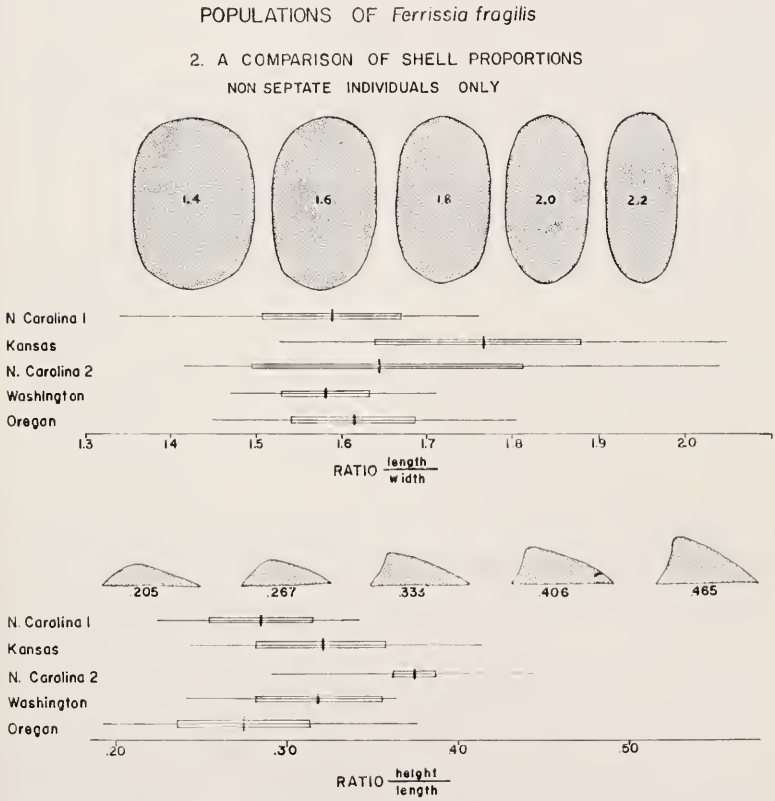

FIG. 18. Comparison of proportions of five populations of *Ferrissia fragilis*. Ranges, means, and standard deviations indicated as on Figure 17. Number of specimens measured same as N for non-septate individuals on Figure 17. Upper group, ratio of length/width (measure of width); lower figure, ratio of height/length (measure of elevation). Note the apparent absence of any geographical trends.

With regard to the third recognizable form, *F. fragilis* var. *isabellae*, conclusions are not at all clear. The name is derived from Lake Isabella, Mason County, Washington, where these snails occur abundantly. In their general appearance they resemble typical *F. fragilis*, but they are larger and somewhat more narrow. Measurement of fifty shells from Lake Isabella yields the following average dimensions:

Length,	3.54 mm.
Width,	2.07 mm.
Height,	1.06 mm.
L/W,	1.71
H/L,	.301.

The form extends eastward into central Washington state, northward into Canada (British Columbia), and into Oregon to the south.

Ferrissia parallela (Haldeman)

Ancylus parallelus Haldeman, 1841, Monograph of the freshwater univalve Mollusca of the United States, no. 3, description on the cover, New England.

Ferrissia parallela (Haldeman). Walker, 1918, Miscel. Publ. Mus. Zool. Univ. Mich. 6: 119.

Description: "Shell pale, thin, and delicate, lengthened, sides sub-rectilinear, diverging slightly forwards: apex rather sharp, conspicuous, with two-fifths of the shell posterior to it. Dimensions: Long. 0.25, lat. 0.15, elev. 0.08 inch." — Haldeman.

Type: ANSP 21996 H.

Distribution: In the northern United States and in Canada, from the Atlantic coast westward; abundant in the smaller lakes in the Great Lakes area.

Ecology: On vegetation, particularly *Scirpus*, *Typha*, etc. in shallow lakes. The form of the shell may be influenced by the long, narrow stems on which the animals live. In all populations I have studied the variation in width is very great. The species seems to prefer clean water but I have collected specimens in muddy, turbid water in shallow swamps in the vicinity of Grayling, Crawford County, Michigan. *Ferrissia parallela* appears to be able to withstand much higher summer temperatures than does *F. rivularis*.

Morphology: Aside from the narrow shell and variably rounded apex, the anatomy of *F. parallela* is similar to that of *F. rivularis*. The flagellum in this species is typically large and robust, the pseudobranch rather small in spite of the lentic

habitat. The specimens I have dissected, mostly from Michigan, have been heavily pigmented. The radula is about the same as that of *F. rivularis*.

Remarks: The large size, characteristically elongated shell shape, lentic habitat, and restricted distribution distinguish this species from other *Ferrissia*, and I believe it to be a distinct, though variable, species. It appears to be a direct descendant of *F. rivularis*.

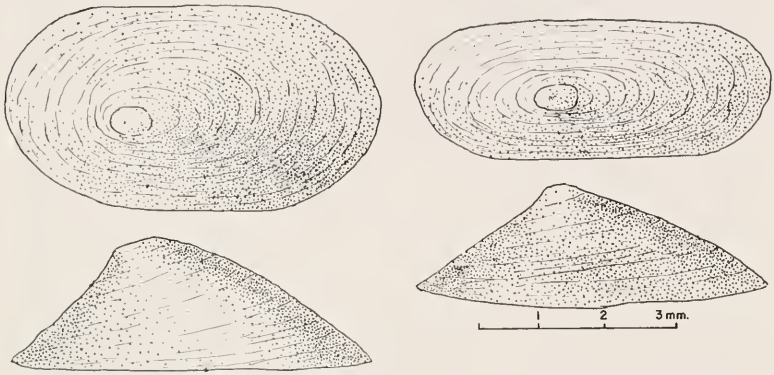

FIG. 19. *Ferrissia parallela*, typical specimens. Howe Lake, Ontonagon County, Michigan.

DISCUSSION

ECOLOGY

As an aid to understanding the phylogenetic relationships of ancylid snails, it is important that the ecology of these animals should be studied in some detail. Although much work of this kind has been done with the two European species and very little with the American forms, it is still of interest to review the ecological observations made upon the family and to try to apply these observations in the interpretation of American species. In this section an attempt will be made to isolate and discuss those elements of the environment which seem most important to ancylid snails. It is realized that an animal responds to its total environment, all of whose elements are bound together in a complex way; a change in one may induce changes in many others. Nevertheless, some physical-chemical and biotic factors have been singled out for special discussion below.

Physical-chemical factors: Any given species of ancylid is normally to be found only in still water (lentic type) or running

water (lotic type), although some exceptions, noted previously, do occur. The presence of a current brings with it some coincidental effects. The oxygen concentration is generally higher and the temperature more stable in running water than in moderately small bodies of standing water. Particles of several types may be carried by the current, and these may be deposited on the stream bed in a complex manner correlated with gradient, flow volume, curvature, and substrate. It is doubtful whether lotic ancylids obtain food directly from the current, as do some filter-feeding animals. Erosion of the shell by the abrasion of small particles may be important, as may respiratory difficulties encountered in highly silted streams.

Many animals, representatives of different phyla, have assumed a "streamlined" shape in lotic environments. Such a shape, found in flatworms, leeches, insects, and ancylids, apparently offers the smallest resistance to the pressure of the water and enables the animal to maintain its position with a minimum expenditure of energy. If this is truly the case, then the orientation of the animal towards the current should be such that the shell presents the smallest frontal area to the current. Although local water movements under and around stones are extremely complex, it has not been my experience to find any particular orientation of *Ferrissia rivularis* with respect to the general direction of stream flow. Schmid (1932), on the basis of field experiments, found that there was no apparent rheotropism in *Ancylus*.

Paradoxically, it should be noted that both in Europe and in America those forms having the lowest shell contour are lentic. The elevation of *Laevapex fuscus* and of *Acroloxus lacustris* is generally lower than that of *Ferrissia rivularis* or of *Ancylus fluviatilis*.

In habitats having heavy wave action, the shape of the shell may be greatly modified. Boettger (1932) found that the shells of *Ancylus* from wave-beaten shores approached a conical shape, with a reduction of the anterior convexity and the posterior concavity. It may be noted parenthetically that such a shape would resemble the shell of *Rhodacmea*. I have never observed *Ferrissia* in a similar situation.

The effects of increasing pressure (depth) upon ancylids are not known, but according to Welch (1952), it seems likely that within limits, pressure is not a very significant factor in inland waters. Ancylids are known from deep lakes, such as Lake

Baikal (Dybowski, 1875), and their shells are occasionally found among the beach drift of the American Great Lakes, but they do not necessarily live at the bottoms of such lakes. Geldiay (1956) found that the numbers of *A. fluviatilis* in Windermere decreased with increasing depth, and that during the breeding season none could be found as far down as five meters. All adults and eggs placed in 12 meters died within four months, presumably from starvation induced by inhibition of algal growth in the darkness.

Temperature effects are certainly of great importance to all animals, and some work has been done with basommatophores, although not specifically with ancylids. A tolerance on the part of *Bulinus* and *Biomphalaria* to a seasonal variation of 18°C in the mean monthly temperature was demonstrated by Hoffman and Zakhary (1954). In Kenya, *Biomphalaria pfeifferi* and *Lymnaea caillaudi* live in habitats showing a diurnal variation of as much as 20°C. *Bulinus contortus* and *Australorbis glabratus* can withstand temperatures of 33°-37°C for up to 15 days, depending upon conditions (Deschiens, 1954).

Temperate zone snails are normally not very resistant to freezing. *Lymnaea stagnalis* and *Planorbis corneus* die after five hours at —5°C (Pelseneer, 1935). I have collected *Laevapex fuscus* from areas in which the ice cover was just breaking up (Michigan), and found that large and robust specimens were present. These animals must have passed the winter as adults at or near freezing temperatures. In these same places summer temperatures may exceed 30°C. It is probably significant to these snails that cold water can hold more dissolved oxygen than can warm water.

Related to and varying to some extent with the temperature is the amount of incident light. The summer sun increases both heat and light, and autumn days are generally both cooler and duller. In the winter, ice may be an effective barrier to light penetration. In my experience, most limpets prefer to remain on the underside of objects in the water; whether this represents a negative phototaxis is not known. I have maintained both *Laevapex fuscus* and *Ferrissia fragilis* var. *shimekii* in aquaria on a well lighted window sill and they appeared to thrive under such conditions. Sunlight permits photosynthesis in rooted vegetation and in microflora, with its resultant release of oxygen. The rate of decomposition of organic remains is increased by the heat from sunlight, and important materials may be released to take their place in the metabolic cycle of the habitat.

Of all the misfortunes which may befall ancylids, drying is perhaps the most disastrous, for these soft-bodied animals are particularly sensitive to desiccation. Ancylids in aquaria often crawl up on the glass above the water line, and invariably die there, only a few millimeters above the surface of the water. The drastic effects of desiccation are exaggerated by the relatively enormous aperture in the freshwater limpets. While most snails with spirally coiled shells have the greater portion of the viscera protected by an impervious covering, in ancylids all of the membranes of the underside of the mantle, with the adjacent heart and kidney, are directly exposed, and a much greater proportion of body surface is naked.

One way in which the effects of desiccation may be minimized is through a reduction in the size of the aperture (septum formation). Such a growth is common in small ancylids living in temporary pools, and was formerly thought to represent a distinct genus.

Although ancylids are pulmonate snails, they do not need to come to the surface of the water to breathe (as does *Lymnaea*). I have often observed the minute limpets crawling upside down on the surface film, but believe that this activity is not primarily related to respiration. Occasionally, populations of ancylids are found out of water in places of extremely high humidity (Brockmeier, 1887; Fischer, 1889; Boettger, 1947), but such a situation has never been reported for an American species.

The problem of oxygen consumption and utilization in lentic and lotic ancylids has been studied by Berg (1952). He found that the actual oxygen consumption of *A. fluviatilis* and *Ac. lacustris* is about the same, varying similarly according to the season, but that the lentic *Ac. lacustris* is far more tolerant of oxygen deprivation and anaerobiosis than the fluviatile species. It might be instructive to repeat some of Berg's experiments using American species. Since the size of the animal and the size and shape of the shell are environmentally influenced, it is probable that oxygen concentration or a similar factor may be significant in their control. If the oxygen concentration is lowered, surface-volume relationships would demand either a smaller animal or reduced metabolic rate in a larger one. Berg found that the rate of oxygen consumption in similar-sized lotic and lentic animals is about the same. Berg, Lumbye, and Ockelmann (1958) found that *A. fluviatilis* consumes more oxygen in the spring and early summer (the reproductive period) than in the winter.

Von Brand, Nolan, and Mann (1948) showed that the pulmonate snail *Australorbis glabratus* maintained a steady rate of oxygen consumption over a wide range of oxygen tensions, and that symptoms of asphyxia became apparent only at about 7 mm. Hg oxygen pressure. Within the range from 3° to 37° C, oxygen consumption increased proportionally with the temperature. I have found that *Laevapex fuscus* survived better in covered aquaria than in those having extra air bubbled into the water. The effects of other dissolved gases upon ancylids are not known.

Ancylid snails have been found living very near to the sea where they are exposed to salt or brackish water. McMillan (1940) found *Ancylus* together with *Lymnaea peregra* living abundantly in a small stream which must be exposed to brackish water twice a day. Stubbs (1900) reported a similar exposure of *Ancylus* to ocean water. I have often found *Laevapex* and *Ferrissia fragilis* living on badly rusted metal in stagnant ponds, indicating a high tolerance to iron and tin ions. The tolerances of freshwater mollusks to various salts should be further studied because of the importance of developing molluscacides for control work with vector snails. The relative tolerance of ancylids to organic pollution has been mentioned previously.

Biotic factors: Aside from their ability to clamp down and adhere firmly to the substrate, ancylids are rather defenseless animals. Consequently, they are subject to predation by many mollusk-eating animals. Alsterberg (1930) records the leech *Glossiphonia* as an enemy of *Acroloxus lacustris*. Pentelow (1932) found that the brown trout will eat *Ancylus*, and fish as predators on ancylid snails are also mentioned by Baker (1916) and Harting (1875). I have seen evidence that the salamander *Eurycea tynerensis* may have ancylid shells in its stomach. Wild and Lawson (1936), Thompson (1841), and others have recorded lists of birds which eat ancylids.

Protozoan parasites have been found in ancylids by Kozloff (1954), and I have found specimens of *Laevapex fuscus* from Michigan whose digestive glands were severely infected with an amoeba closely resembling *Entamoeba coli*.

The work of Smith and others on trematode parasites has been mentioned above. This area of investigation is almost untouched and promises to be increasingly important in the future.

Externally, ancylid snails are often covered with ciliates, such as the peritrich *Cyclochaeta*. Annelid worms of the genus *Chaetogaster* are commonly found crawling on the animals beneath

the shell, particularly in stagnant habitats. Geldiay (1956) found an oligochaete and a chironomid larva beneath the shell of *Ancylus fluviatilis* in England. The outside of the shell is frequently covered with colonial algae and protozoa (*Vorticella*, etc.), and sometimes *Hydra* may be found living in this assemblage in lentic habitats.

Other animals have various relations with ancylids. Mussels and gastropods may serve as substrates for the limpets. In many streams with sandy bottoms ancylids may be found only on living or dead mussel shells. Freshwater limpets may be transported by a variety of other animals, including birds (Kew, 1893) and beetles (Darwin, 1860; Cooper, 1907; Buttner, 1953; Johnson, 1904). In a recent review, Macan (1961) has assembled a great deal of information on environmental factors affecting the range of many different freshwater animals.

The relations of ancylids to plants are complex and vary according to the species of limpet. Fluviatile species may very seldom come in contact with rooted vegetation; lentic species may spend all of their lives on the stems of vascular plants. I have examined the stomach contents of many ancylids from various habitats and find that there are always many diatoms present. It seems probable that the limpets ingest these diatoms together with other algae and, if available, the outer layers of larger plant stems and leaves. Limpets always have a large number of sand grains in their stomach and intestine, causing difficulty in histological sectioning.

I have found ancylid snails living upon the following plants: *Sagittaria*, *Nymphaea*, *Nuphar*, *Scirpus*, *Potamogeton*, *Typha*, *Sparganium*, *Cyperus*, *Carex*, twigs and leaves of various trees, and practically any larger aquatic plant. The shape of the shell, particularly in *Ferrissia parallela*, may be greatly influenced by the size and shape of the substrate.

Life history: In recent years several excellent papers have appeared which describe the annual life cycle of *Ancylus fluviatilis* (Hunter, 1953, 1961a, b; Geldiay, 1956). It is the conclusion of these authors that in the British Isles *Ancylus* has a simple annual life cycle, but that this cycle is quite variable from year to year. While such elegant and detailed studies remain to be done on an American species, I believe that there is little difference between the annual cycles of *Ancylus* and *Ferrissia*. Figure 13 shows population histograms of *F. rivularis* from different areas, all collected at about the same time of the year. It is evident

that the distribution of sizes is generally bimodal, with peaks corresponding to the previous year's and the present year's crops of individuals. There is no reason to assume a more complex life cycle or life history pattern.

I have observed mating in *Laevapex* several times, but have never seen it in any other ancylid. In the cases that I observed, the behavior of the snails agreed well with the description given by Clapp (1921). The peculiar chain copulation, described by Geldiay (1956), where as many as seven individuals are involved, each mating with the two adjacent snails, has never been described in any American species.

The eggs and early development of *Ferrissia fragilis* var. *shimekii* have been described by Basch (1959b).

Phylogeny

It is difficult to arrive at any coherent phylogenetic conclusions with the small amount of evidence available today. The elucidation of the anatomy of *Hebetancylus* and its evident relationship to *Laevapex* suggest that far more attention should be paid to tropical ancylids in the attempt to understand relationships within this complex group.

Owing to many similarities in general appearance it is likely that the ancylids as a group are descended from ancestors belonging to the family Planorbidae. Planorbid snails are highly

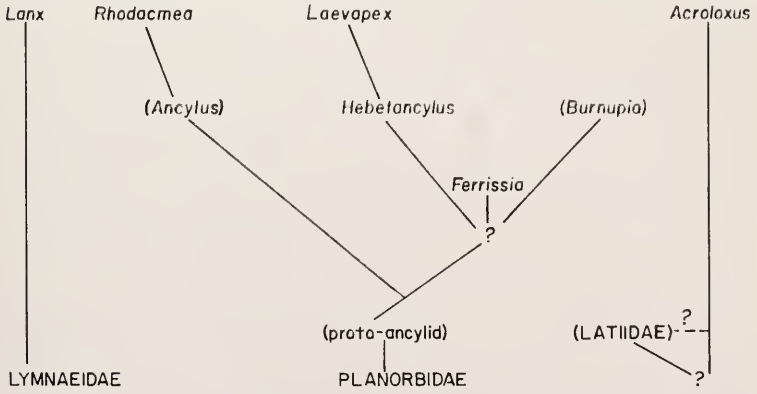

Fig. 20. Probable relationships among North American freshwater limpets. Groups shown in parentheses are not now known to occur in North America. *Burnupia* has not been reported from North America but apparently is present in the Caribbean area. Relationship of *Acroloxus* to the Latiidae after Hubendick, 1962.

variable and illustrate a great variety of shell forms, from the classical *Planorbis*-type through ultra-dextral, physoid, and paucispiral species. The proto-ancylid stock may have developed from the *Planorbis*- or *Segmentina*- tribes of Hubendick's subfamily Planorbinae (Hubendick, 1955).

One may presume that the bilaterally symmetrical shell of ancylids has arisen primarily as a response to a swift current, but this is not necessarily so, for many marine limpets with a strikingly similar shell shape live in areas lacking currents (although wave action is present). The genus *Patelloplanorbis* (Hubendick, 1957) has a reduced spire of two whorls and lives in a lake in New Guinea. It is likely that those forms with a more widespread geographical distribution may represent older stocks, and that those with a restricted range are more recent offshoots. Such an argument is reasonable, but one must remember the present minute range of *Acroloxus* in North America, although fossils of the genus are known from a much larger area. The time element must be considered in studying distributions, but unfortunately our knowledge of fossil ancylids is extremely scanty. Presuming that the widespread stream forms are primitive, the genera *Ancylus* and *Ferrissia* would have to assume a basic place in ancylid phylogeny. Both of these genera include animals with flagellate penes, although the nature of the flagellum is different. *Hebetancylus* also is a widely distributed genus possessing a flagellated penis. It is interesting to note that animals of *Rhodacmea*, *Burnupia*, and *Laevapex* lack a flagellum (see Brown, 1961 for anatomy of *Burnupia*). Perhaps the loss of the flagellum has occurred several different times in this group. The position of *Rhodacmea* is particularly difficult to assess: on distributional grounds it appears to be an isolated derivative from an *Ancylus*-like ancestor, while the chromosome number (Burch, et al., 1960) would seem to place it in an ancestral position. Further biological investigations, such as the excellent cytological work by Burch (1959, 1960) will do much towards illuminating these complex relationships.

At this moment, ancylid snails appear to fall into two major groups (see Fig. 20). One group includes *Ferrissia*, *Hebetancylus*, *Laevapex*, and *Burnupia*, and possibly several other poorly known tropical genera, all of which have basically similar radulae. The second group includes *Ancylus* and *Rhodacmea*, in which the shell, animal, and habitat are all quite similar, and the radula shows some similarity (particularly in the marginal

teeth). Associating these two large groups are similarities in body form, the nature of the digestive tract, and the peculiarly shaped kidney; further investigation may reveal a "common ancestor" between the *Ferrissia* stock and the *Ancylus* stock, referred to in Figure 20 as the proto-ancylid.

APPENDIX

Directions for Dissection

The following materials are necessary for dissection of ancylid snails:

A good binocular dissecting microscope and strong focusable light source.

A small container with paraffin poured into the bottom for use as a dissecting pan. A Petri dish, watch glass, or similar container is suitable.

Insect minuten nadeln, or bits of very fine wire for pinning.

Forceps. The best are DuMont No. 5, made in Switzerland and available from any jeweler's supply house. Also useful are DuMont No. 3C forceps or equivalent.

A small sharpening stone of fine texture for the forceps.

Fine needles. Good quality sewing needles may be embedded in glass or wooden handles. One or more ground down to a spatulate shape will be found most useful. Several with fine points are indispensable.

Dropping bottles of one or two-ounce size containing 70% alcohol, 5% formalin, glycerine, water, stains, etc. A wash bottle made of polyethylene and filled with 70% alcohol is useful.

Glass slides and cover slips, particularly small round ones.

Wax or diamond point marking pencils.

Medicine droppers.

Fine camel's hair brushes for handling shells.

For general anatomical study, the best specimens for dissection are those previously relaxed, fixed, and preserved in alcohol. I have generally used 1% nembutal solution as described earlier in this paper for anesthetization, and formalin-acetic acid-alcohol or Bouin's solution as fixatives. It should be noted that shells are destroyed in these solutions; where these are desired intact, animals may be fixed in alcohol alone or weak formalin, although tissues are not so well preserved.

The dissecting dish should have at least 5 mm. of hard paraffin in it, preferably 1 cm. It is much easier to see the organs in fluid if the paraffin used is black. The edges of the dish should be high enough to permit at least 5 mm. of fluid to cover the paraffin, and it should be prepared in such a way that the "plug" of paraffin does not float. When dissecting, care should be taken that the light beam does not melt the paraffin around the specimen, for this quickly obscures the field of vision. If the dissecting container is very small, the fluid may heat up rapidly and cause the paraffin to melt or become soft, and the dissecting pins to sag or drift; hence a moderately large container is preferred if long periods of dissecting are contemplated. A circular container such as a Petri dish can be rotated easily to bring different aspects of the specimen into view. Where several specimens are being compared, the paraffin surface should be as flat as possible to minimize changes in focus of the microscope. It is useful to have the appropriate literature and anatomical diagrams nearby for consultation during the dissection.

Specimens selected should be large and typical, unless another stage is specifically desired. The shell can be grasped with forceps and a flattened needle slipped between the inner surface of the shell and the shell muscles to remove the animal. Care should be taken not to break the delicate dorsal epithelium nor to crush the kidney. When the animal is free, notes should be made of pigment distribution and other external features: tentacles, mouth, pseudobranch, foot, etc., and the animal should be pinned down by inserting a sharp pin through the right anterior shell muscle. It is important that there be sufficient fluid covering the animal to prevent optical distortion from the surface film.

Using the finest forceps, peel away the upper layer of the mantle starting in the mid-dorsal area, pulling away thin strips towards the left side to the mantle edge, and exposing the heart and kidney area. If this is done with care, it will be noted that over the mid-dorsal region the mantle is composed of two delicate layers, the upper one of which is pigmented. It may be possible to observe the left pallial nerve which passes between the kidney and its covering epithelium. When the entire kidney is exposed, note the relationship between this organ and the heart. The renopericardial duct is not visible at this magnification, but if it is desired to see this duct the entire heart-kidney complex may be removed from the animal by carefully tearing

out the left side of the mantle between the shell muscles. A compound microscope will reveal the duct and finer kidney structure, particularly if the preparation is lightly stained and mounted in glycerine. The pulmonary cavity, which lies just below the heart, will now be exposed.

The rest of the mantle epithelium may be removed, revealing the organs of the visceral mass. The bulk of this area is filled with the digestive gland, and the loop of the intestine should be clearly visible superficially, passing from the muscular stomach and caecum to the right side and then back across the animal to open on the pseudobranch. The ovotestis may be visible in the right rear quadrant of the visceral mass, slightly different in color and texture from the digestive gland in which it is embedded. By picking away the digestive gland, the esophagus and stomach are exposed, and beneath them the glands of the reproductive system. Great care is necessary to avoid damaging the hermaphroditic duct and seminal vesicle leading from the ovotestis, for digestive gland tissue often adheres to the delicate duct walls. Note the thin hemostatic membrane (Membrane of André) traversing the body anterior to the stomach. The membrane may be removed, the esophagus broken anterior to the stomach, and the entire digestive tract can be lifted out of the animal; usually the intestine must be broken at the point where it passes through the body wall on the left side near the anus. Note the small caecum opening from the stomach at a point just proximal to the beginning of the intestine. The contents of the digestive tract, largely sand and diatoms, may be placed on a slide for examination under a higher powered microscope.

At this time the skin may be removed from the top of the head and from between the two anterior shell muscles. Care should be taken not to remove the eyes or tentacles or nerves leading to them. The buccal mass will now be exposed to view in most specimens, but occasionally the reproductive glands extend into the head and partially cover it. The salivary glands, radular sac, and remnant of the esophagus should be identified. On the left side anterior to the shell muscle the penial complex should be visible. After the salivary glands have been removed, the pair of small buccal ganglia may be seen lying upon the buccal mass; these can be freed from their connections with fine needles, and the buccal mass removed intact, with as little damage to the nervous system as possible. From the buccal mass the radula may be extracted by disintegrating the tissue in KOH or in

Clorox (Basch, 1961). The various ganglia of the brain should now be clearly visible.

The reproductive system can next be examined in detail. If all of the portions within the visceral mass have remained undamaged, connections can be observed of the hermaphroditic duct to the central area of glandular tissue, and from these glands the vagina can be seen leading to the female genital opening beneath the pseudobranch (which can be removed). The spermatheca or seminal receptacle is a blind pocket at the end of a small duct branching off the vagina. Tracing the vas deferens is a challenging exercise in dissection, but with patience it can be followed in most specimens. It is best to locate the area of the male genital opening behind the left tentacle and to pick away the skin and superficial connective tissue just posterior to this opening. The vas deferens may be seen running longitudinally, lateral to the left anterior shell muscle, to a point near the female genital opening, where it turns abruptly inward to run free in the visceral cavity for a short distance. When the greater part of the length of the vas deferens has been exposed, the preputium and penial complex may be gently removed from its place by tearing the base of the preputium at the point where it becomes continuous with the male genital opening. Care should be taken not to break the vas deferens or the flagellum (if there is one). When the vas deferens has been freed from the skin and connective tissue back to the point where it turns inward, the common duct of the vagina and spermatheca may be cut off at its point of exit from the body and the entire reproductive system removed intact. It requires considerable practice before this dissection can be accomplished consistently.

The reproductive tract may be placed entire into a drop of glycerine on a slide, and the organs separated from one another with fine needles. At this time it is often helpful to view the structures under incident, oblique, and transmitted light. The preputium should be teased away from the penis, and the latter organ examined (under a cover slip) with a high powered microscope.

The carcass will now contain the brain and nervous system together with the shell muscles and ventral head-foot musculature. The ganglia of the brain should be easily visible, and the major nerves leading to the tentacles, eyes, mouth, and other regions followed.

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STUDIES ON SOUTH AMERICAN ANOLES

Description of *Anolis mirus*, New Species, from Rio San Juan, Colombia, with Comment on Digital Dilation and Dewlap as Generic and Specific Characters in the Anoles

BY ERNEST E. WILLIAMS

CAMBRIDGE, MASS., U.S.A.

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No. 9 — *Studies on South American Anoles*
Description of Anolis mirus, *New Species, from Rio San Juan, Colombia, with Comment on Digital Dilation and Dewlap as Generic and Specific Characters in the Anoles*

By Ernest E. Williams

INTRODUCTION

In collaboration with several others (Underwood, Ruibal, Rand and Lazell), I some time ago began an investigation of the genus *Anolis,* taking as my starting point the Greater Antilles and venturing from there to the Lesser Antilles. By an inevitable progression my study has led me to the mainland. Not only have certain species reached the mainland (or at least its fringes) as invaders from the islands but the ultimate source of all the island faunas must be sought somewhere within the mainland assemblages.

It is, however, disconcerting to find that the anoles of South America — the largest mainland area inhabited by the genus — are not only poorly understood but hardly worked on at all. Since Boulenger's survey of the genus as a whole in his catalogue of 1885, there has been almost no attempt at revisionary studies of the anoles of any part of South America. Only a single paper by Dunn (1937) on the giant anoles of the area may be regarded as a significant effort in this direction. The lists by Burt and Burt (1933) and Barbour (1934) are devoid of analysis or useful comment. Beyond this, the whole of the pertinent literature consists of short, mostly uncritical, lists of the anoles of a single region or of descriptions of new species, usually insufficiently compared with supposedly related forms — if, in fact, related forms are cited.

Because of this lack of revisionary studies, the *Anolis* of South America are of all the elements of this difficult genus the ones in gravest need of attention.

The descriptions in the available literature are not useful: They are not consistent; they do not cite characters now known to be significant; they do not discriminate between forms that require to be distinguished and do separate forms that require to be united. There are species that have been named again and again, and also species without names. The application of many names is clouded and doubtful.

A clarification of the taxonomy of South American anoles is thus imperative. This task, however, will not be easy.

Perhaps in few other genera is it so necessary to confront one specimen with another. No standard description, however detailed, quite takes account of all the ways in which anoles may differ. Mere counting and tabulation does not suffice; it is necessary to look at all the usual and standard characters and then to look again.

But there is another difficulty, more fundamental than that of getting present collections together in one place. It is the fact that the collections that do exist, large in total numbers though they may be, are very conspicuously inadequate in their coverage of continental South America. *Anolis* is not, in most of South America, a genus easily or abundantly collected. Except for a few species, series of any form are few and from few localities. Inevitably, discrimination between individual and geographic variation is difficult and, quite certainly, our conception of patterns of evolution within the genus is rudimentary and is likely to remain so for some time.

But quite apart from the difficulties which face a revision of the classic type for this genus, there is much evidence that preserved specimens are inadequate for the recognition of species. We need evidence on the biological aspects of the species as well as on the morphology of cadavers. We need to know colors in life and ecology and ethology — the kind of information now being obtained for the West Indian anoles. This sort of information has ordinarily been totally lacking for South American anoles. As matters stand, we are likely to dismiss species difference as individual variation or perpetrate the reverse error.

Thus, the taxonomy of South American anoles is and will for some time remain in a very primitive stage. The procedures which must be adopted for the study of the genus in South America are utterly different from those which are possible in the West Indies. It is first of all necessary to redescribe the types of available names so that they may be recognized when encountered. It will then be necessary to group recognizable forms together in larger assemblages. In the present state of our knowledge these groupings will sometimes be natural and sometimes artificial; they will sometimes be species, though including several named forms; they will sometimes be superspecies, sometimes species groups or perhaps even subgenera, *but they will also sometimes be convergent unnatural assemblages.*

It is necessary to make these admissions; it would be idle and misleading to pretend that it is at the moment possible to make correct assessments of subspecies-species-species-group levels for many continental South American *Anolis* complexes. We are only at the beginning of the study; the first task is to reduce the present chaos segment by segment to a manageable order which will, however, be only a first approximation to the realities. It is the intention of this series to attempt, bit by bit, this first approximation.

A PECULIAR NEW SPECIES FROM COLOMBIA

To describe a new species based on a single specimen in a series devoted to the clarification of chaos within the genus *Anolis* may seem anomalous. It is, however, my belief that alongside the wilderness of current names there lies a real wealth of species. As old names come to be given their proper place, many a species now falsely and variously assigned will be recognized as new. In the present case the species to be described is (for a South American *Anolis*) very distinct. It is in several respects sufficiently unusual that I call it by the Latin name which means "astonishing":

Anolis mirus new species

Type: British Museum (Natural History) 1910.7.11.5, Rio San Juan, S. W. Colombia, coll. M. G. Palmer.

Diagnosis: Closely allied to *A. fraseri* Günther and similar in size and many aspects of squamation, but differing most prominently in the number of lamellae under phalanges ii and iii of the fourth toe (15 rather than 21), the first phalanx longer than phalanges ii and iii together and arising at the end of the expanded portion of the toe, rather than within the expanded portion.

Description. Head. Head scales small, weakly keeled anteriorly, smooth posteriorly; 12 scales across snout between second canthals; frontal depression shallow; 7 scales border rostral posteriorly; 3 scales between scale surrounding nostril and rostral; 8 scales between supranasals.

Supraorbital semicircles separated by 4 scales from each other and in contact on each side with enlarged supraocular scales; no well defined supraocular disc; supraocular scales moderately enlarged medially, posterolaterally and mediolaterally, but *a*

middle portion of the supraciliary margin with smaller subgranular scales; 2-3 overlapping short supraciliaries anteriorly bordered medially by polygonal enlarged scales; canthus distinct, of about 8 scales decreasing in size anteriorly, the third largest, the series not continued to nostril; 7 loreal rows, the dorsalmost largest.

Temporal and supratemporal scales subgranular (one or two rows of temporals closest to orbit, enlarged); a *triangle* of enlarged scales separating the two areas and tapering posteriorly into a double or triple row of scales which curve downward toward the ear, decreasing in size as they go until they grade into the granules around the ear: supratemporal scales distinctly smaller than the enlarged scales surrounding the interparietal, which lies in a shallow triangular depression; interparietal smaller than ear, separated from the supraorbital semicircles by 4 enlarged scales; all scales in the interparietal depression enlarged, the largest lateral and lateroposterior to the interparietal, these sharply distinct from the subgranular scales of the dorsum.

Suboculars weakly keeled, separated from supralabials by a row of scales about half as large, anteriorly separated from the canthal ridge by 4 scales (5 counting subcanthal), posteriorly tapering upward to join the supratemporal triangle described above; 10 supralabials to center of eye.

Mentals wider than long, in contact posteriorly with 6 scales between infralabials; sublabials not distinctly differentiated, several rows medial to infralabials enlarged, keeled; central throat scales small, swollen, rectangular, smooth, becoming larger, polygonal, keeled laterally.

Trunk. Two middorsal rows tending to be swollen, conical, keeled, grading into lateral scales which are smaller, rounded, separated by minute granules, indistinctly keeled; ventrals larger, weakly keeled, keels oblique.

Gular Fan. Large with wide areas of naked skin crossed by rows of small scales; edge with scales nearly equal in size to ventrals or somewhat smaller, multi- or bicarinate in several rows. Several folds in sides of neck, the dorsalmost very prominent, continued above shoulder in an area marked by a light spot.

Limbs. Scales on limbs keeled or multicarinate, the largest smaller than the ventrals. Digital scales multicarinate. *Fifteen lamellae under 4th toe, distal segment not raised.*

Tail. Somewhat compressed, but with no dorsal crest or distinct verticils. Greatly enlarged postanals present.

Pattern. Head and body dark brown with indistinct oblique rows of small light dots on sides of body. A light patch in front of shoulder continuous with light skin and scales of dewlap.

Size. Snout-vent length 105 mm.

Relationships

Anolis mirus is one of the South American giant anoles ("*latifrons* group" in the sense of Dunn, 1937). Among these it resembles *A. fraseri* in a number of respects (Table 1) which are peculiar enough among the giant South American anoles to imply special relationship: the ventrals are weakly keeled; the midvertebral scales tend to be conical, higher than long, becoming almost a crest; the sides of the neck have complex skin folds; the scales surrounding the interparietal within the interparietal depression are rather uniformly enlarged and abruptly larger than the supratemporal scales.

In two respects it resembles *A. biporcatus* with which *A. fraseri* has sometimes been confused. There are 2-3 overlapping supraciliary scales and the suboculars are separated from the supralabials by a row of scales. In the first of these features *mirus* appears merely to be relatively primitive, since most *Anolis* have elongate and overlapping supraciliaries.[1] In the second feature, *mirus* may again be primitive since *fraseri* is specialized or at least unusual in this regard as compared with other members of the giant South American anoles. The resemblances of *mirus* to *biporcatus* thus seem merely convergent and in most regards *mirus* differs from *biporcatus* in just the ways that *fraseri* does. R. Etheridge who has studied X-rays of *Anolis mirus*, *A. fraseri* and the other South American giant anoles (*sensu* Dunn) finds that all these belong to a section (his alpha section) quite distinct from the beta giants of Central America, of which *A. biporcatus*, *A. petersi*, etc. are members.[2]

[1] The swollen and quadrate supraciliaries of *fraseri* are an approach to the condition of *A. latifrons* Berthold (which differs in color and many other respects). The morphological series, beginning with the species showing most extreme specialization, is *latifrons, fraseri, mirus* (this with *short* overlapping supraciliaries), most species of *Anolis* (e.g. *princeps* Boulenger with one or more elongate supraciliaries). Both *A. fraseri* and *A. latifrons* will be further discussed in succeeding papers of this series.

[2] Recognition of these two sections by Etheridge (unpublished thesis, University of Michigan) is a major breakthrough in anole systematics. Based on the presence (beta section) or absence (alpha section) of transverse processes on the autotomic caudal vertebrae, these sections make extraordinarily good systematic and zoogeographic sense.

TABLE 1

mirus	*fraseri*
12 scales across snout between second canthals.	8 scales across snout
7 scales border rostral posteriorly	5-6 scales border rostral posteriorly
A middle portion of the supraciliary margin with small, granular scales	All of supraciliary margin with enlarged swollen scales
2-3 short overlapping supraciliaries anteriorly.	*No* overlapping supraciliaries.
Suboculars separated from supralabials by a row of scales ½ as large.	Suboculars broadly in contact with supralabials.
A well marked, wide, skin fold above shoulder, made conspicuous by a light coloration continuous with light skin and scales of dewlap.	Several folds of skin above shoulder, none very wide nor made prominent by a light coloration continuous with light skin and scales of dewlap.
15 lamellae under phalanges ii and iii of 4th toe.	21-23 lamellae under phalanges ii and iii of 4th toe.
First phalanx longer than phalanges ii and iii together, arising *at the end* of the expanded portion of the toe.	First phalanx distinctly shorter than phalanges ii and iii, arising *within* the expanded portion of the toe.
Ground color dark. Oblique rows of small dots on flanks.	Ground color light. Broad dark transverse bands.

GENERIC CHARACTERS OF ANOLES

Two of the more extraordinary peculiarities of *Anolis mirus* are worth attention because of their implications in regard to the significance (1) of gular folds and (2) of toe structure in the generic subdivision of the anoline lizards. They are therefore given extended discussion.

1. *Gular folds*

I think we may safely assume that one of the primary specializations of the genus *Anolis* is the dewlap — the longitudinal gular fold extensible by means of muscles acting upon the processus retrobasalis of the hyoid (see von Geldern, 1919, for details). It is not clear whether, primitively, the dewlap was as large or as capable of extreme expansion as in some modern

species, but it is very probable that in *Anolis* it was primitively both a simple and a fully functional mechanism. From this simple condition, divergence has taken place in two directions: (a) toward development of transverse and lateral folds and (b) toward reduction of the longitudinal fold. Often the divergence may be traced through intermediate stages toward specialized end conditions.

One such specialized end condition, involving development of a peculiar lateral fold, is seen in *mirus*. Here the intermediate condition can be seen in a closely related species. Thus, the singular light-colored fold high on the neck, so evident in *mirus* (Figure 2), appears to be an exaggeration of a feature initiated in *fraseri* (Figure 3). Complex neck folds such as those seen in *fraseri* are seen in other anoles, e.g. in *Anolis cybotes* and (more conspicuously) in *Audantia* (= *Anolis*) *armouri* or *A. shrevei*, all of Hispaniola. (Simple neck folds are present in other anoles, though ordinarily prominent only in females.) I have, however, seen no real parallel to the situation in *mirus*. There, the dorsalmost horizontal fold above the shoulder is impressively widened, several times the width of the small folds ventromedial to it, so that it prominently overhangs the insertion of the arm and at the same time the light color of the dewlap area is continued up onto and above it so that the area stands out prominently against both the dark shoulder and the dark unfolded portion of the neck in front of it.

In some *fraseri* a similar but weaker fold may sometimes be lighter underneath or at its edge but, because the fold is very much weaker and the color never (as in *mirus*) extends as an arc of light pigment on its dorsal surface, the area is never anything like so prominent as in *mirus*.

A series rather similar to *fraseri-mirus* is seen in *cybotes-armouri*. The extreme prominence of transverse and lateral neck folds is striking enough in *armouri* that this taxon from the mountains of southern Haiti has been made the type of the genus *Audantia* Cochran 1934.[1] Recent field investigations in Haiti have shown, however, that between the supposed montane genus and *cybotes* (a common species of the surrounding lowland) there is almost smooth intergradation at all intervening levels. Indeed, the lowland species, when carefully examined, shows

[1] Since the type series were not fully adult, the transverse folds were more prominent than they are in full size specimens. The type of the type-species, *armouri*, is correctly called a female in the original description (Cochran, 1934), incorrectly reported as a male in the "Herpetology of Hispaniola" (Cochran, 1941).

even at sea level some development of lateral folds and the montane population has therefore merely accentuated a trend already evident in lowland populations. Cleared and stained specimens of *cybotes* and *armouri* cannot be separated on any osteological grounds. Strong development of transverse gular folds is not, in this instance, even a specific character.

A trend toward reduction of the dewlap is probably more common than the trends toward its complication. The occurrence of the dewlap in males only may be the first stage in the development of this trend. In many South American and a few West Indian anoles the dewlap is present and equally or almost equally developed in both sexes. In some South American and most West Indian species only the males have the dewlap well developed. Whatever the sequence of evolution in this case — whether a dewlap present in both sexes is primitive or advanced — the change-over must have taken place several times and forms suspected to be closely related may differ in this one character.

In Hispaniola four taxa have the dewlap small, nonfunctional — *Anolis monticola*, *A. aliniger*, and the two species or subspecies *A. hendersoni* and *A. baharucoensis*. The last two forms are very close and all four taxa belong to the same series[1] of the genus, but there are, at all events, three independent instances of dewlap reduction here.

A further example of dewlap reduction is known in Cuba in two species — *vermiculatus* and *bartschi*. These, since the dewlap is wholly lost and a simple transverse fold has been emphasized, have been referred to a distinct genus, *Deiroptyx* Fitzinger. There is no question here of close relation to the Hispaniolan species mentioned above (though they again belong to the same series) and this is still another independent case (or two independent cases?) of dewlap reduction.

Thus, trends of two kinds are exhibited by the anoline gular region. Several species have gone off to varying degrees in one or both (*"Deiroptyx"*) of the two directions; but annectant forms exist (in one case the difference is not even at the species level) and no major groupings have emerged that clearly deserve generic rank. The most nearly deserving case is *"Deiroptyx,"* and even this is trivial (and very possibly polyphyletic). While

[1] I here refer to the "series" set up by Etheridge in the unpublished thesis already cited. These series, which are established on osteological characters seen in X-Rays, fit — with some few exceptions — the evidence provided by external characters as to anole relationships and furnish at the least very useful preliminary groupings for the future study of anole evolution.

the enormous genus *Anolis* may very possibly be usefully split, it is clear that use of gular differentiation would separate only a few end twigs from the bush, and even these not cleanly or clearly.

2. *Toe structure*

A specialization considered diagnostic of the anoline lizards is the peculiar toe structure with a narrow terminal phalanx. One genus — *Norops* Wagler 1830 — has been separated from the other anoline lizards on the structure of the digital pad. Our current concept of this genus dates from Boulenger (1885), who stressed the narrowing of the digital dilation but above all the fact that the distal joint was not "raised."

This definition of *Norops* has never been an easy one to use. Schmidt (1939) has commented on the confusion: "The facility with which *Norops* and *Anolis* are confused is shown by the curious synonymy of the species. Mr. Parker informs me that Boulenger's *Anolis rosenbergi* from Buenaventura, Colombia, may be added to the three synonyms of *Norops auratus* cited in the Catalogue of Lizards. Stuart (1934, p. 10) refers *Norops yucatanicus* Barbour and Cole to the synonymy of *Anolis tropidonotus*. The *Norops* of Matto Grosso and Paraguay is clearly *Norops meridionalis* Boettger, twice redescribed by Boulenger, with impartiality as to generic allocation as *Norops sladeniae* and *Anolis holotropis*."

Schmidt was led to this comment by his observations incident to the description of *Anolis barkeri*, for which he remarked, "The terminal phalanx is less distinctly set off from the widened portion than in normal *Anolis*."

Somewhat like *A. mirus*, *Anolis barkeri* is a relatively large anole (type: 86 mm snout-vent length) with a relatively low number of toe lamellae (*ca.* 16 under ii and iii of fourth toe in MCZ 58221). As in *A. barkeri*, so in *A. mirus* the "dilated" portion of the toe is very little wider than the distal portion and the latter is *not at all* "raised" above the dilated portion. (Compare in Figure 1 the lateral view of the toes of *A. fraseri* and *A. mirus*, in which the difference between "raised" and "not raised" distal portions is well shown.)

Boulenger emphasized in distinguishing *Norops*, however, just this character of "distal phalanx not raised." On this feature, therefore, both *mirus* and *barkeri* would be *Norops*. Schmidt (1939) explicitly rejected this conception, stating: "The nature of the digits cannot be interpreted as in any way an approach

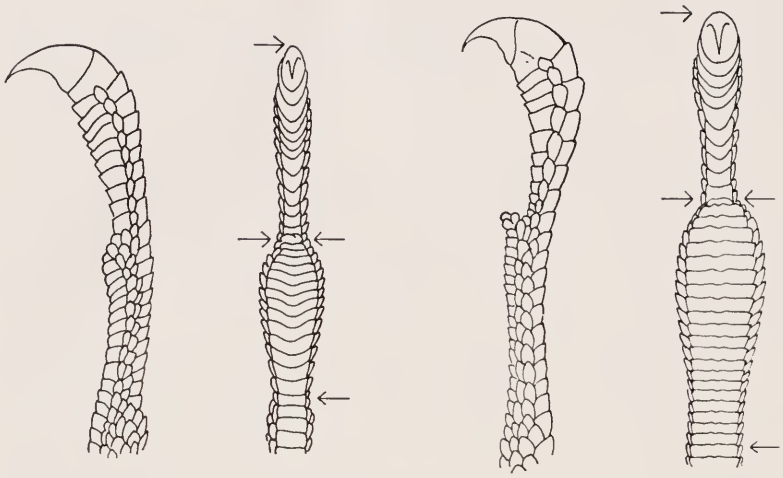

Figure 1. *Left:* lateral and ventral views of fourth hind toe of *Anolis mirus* new species, Type BM 1910.7.11.5.
Right: lateral and ventral views of fourth hind toe of *Anolis fraseri* Günther, ANSP 25563. The arrows permit comparison of the area under phalanx i with that under phalanges ii and iii.

to *Norops,* in which a distinctive habitus and scutellation are combined with the simple stage of digital dilation."

It is true that the forms which Schmidt regarded as *Norops* (*auratus, meridionalis, marmoratus, ophiolepis*) have a common habitus and scutellation; all have keeled ventrals, large flank scales, and a distinct zone of enlarged scales middorsally in combination with a narrow and simple digit. But Schmidt neglected to notice that not a few species currently referred to as *Anolis* approach these animals in varying degrees in all of these features (e.g. *A. notopholis, A. bitectus, A. tropidonotus, A. semilineatus,* in addition to others). There is no ground for belief that these *Anolis* species (all superficially similar) are very closely related to each other, or to the forms currently referred to *Norops.* Some of these have a better developed dorsal zone and narrower digits than some *Norops.* Thus *Anolis notopholis* has a wider zone with larger scales than "*Norops*" *meridionalis* and narrower digits than "*Norops*" *ophiolepis.*

It is, in fact, probable that "*Norops*" *ophiolepis* of Cuba is closer to *Anolis sagrei* also of Cuba than it is to the "*Norops*"

of South America, while *"Norops" auratus* — the type of the genus — is probably as close to *A. chrysolepis, A. scypheus,* and *A. lentiginosus* as it is to *"N." meridionalis.* Again, as with dewlap differentiation, and even more impressively, we are confronted with convergent approaches to a similar stereotype occurring many times and from many directions. The evidence now suggests that the *Norops* condition of the anoline toe is a secondary simplification and not a primitively simple condition.

It again supports this picture of multiple approaches to the *"Norops"* toe structure that *A. mirus* and *A. barkeri* are not at all closely related. As in its gular differentiation, so in its toe structure, *Anolis mirus,* after beginning in a fashion similar to other forms, has taken off in a direction uniquely its own. Thus, a feature unique to *mirus* is the extreme elongation of the distal phalanx. In no other species of anole known to me is the distal phalanx longer than the second and third phalanges together.

Again, in the relation of body size to lamellae number, *mirus* is unlike any other anole. This is a large anole but in contrast to all other species of equivalent size, the number of lamellae under the fourth toe is extraordinarily low. In anoles the number of lamellae under phalanges ii and iii of 4th toe (the dilated portion of the toe includes all of phalanx ii and part of phalanx iii) varies between a minimum of about 11 to a maximum of about 50. *A. mirus* with 15 is very close to the lower extreme of the range although in size it ranks with the "giant" anoles (arbitrarily defined as those of 100 mm or more in snout-vent length).

The type of lamellae here discussed — transverse scales provided with microscopic hairs and imbricating distally — has been at least twice evolved — in geckos as well as in anoles. In both geckos and anoles it has been shown that there is a tendency for increase in lamellar number with increase in size (Hecht, 1952; Collette, 1961). It is this tendency which appears to be contradicted by *A. mirus.*

Collette (1961) has suggested that in addition to size a factor which he terms "arboreality" must be involved and calls attention to an apparent tendency to lower lamellar number in species (and ages and sexes) which spend most of their time on the ground. Certainly, if the generally agreed-upon association of high lamellar number with more effective climbing ability per unit weight is valid, a terrestrial niche for *A. mirus* would seem an almost obligatory inference. Table 2 shows lamellar number and body size (snout-vent length) for the largest anoles as

well as a sampling of this information for anoles of only slightly smaller size. Snout-vent length is here, of course, used for a datum — body weight — which is not available. In a comparison of species of different body proportions, snout-vent length is necessarily an inexact analog of the desiderate information; it is, however, as close an approximation as can be had.

Similarly crude but, I think, similarly useful is the simple index provided by dividing lamellar number by snout-vent length. This at all events makes vivid the fact that the correlation between body size and lamellar number in large anoles is very imperfect. It is, for example, conspicuous that *A. mirus* is the most extreme exception to this postulated correlation.

It will be noted that there is a geographic aspect to the data — that certain related West Indian species display the greatest known sizes and the highest known absolute lamellar number, and that the association of high lamellar number with large size is least evident in the South American giant anoles of the *latifrons* group (*fraseri, latifrons, princeps, squamulatus*). *A. fraseri,* which I have regarded as the closest relative of *mirus,* is closest in lamellar index.

Obviously we have here in the toe lamellae a fundamental taxonomic feature which should never be neglected in discussions of anoles. But more important we have a functional and evolutionary problem of extraordinary interest. The mode of function of the lamellae is not understood, and in consequence the significance of lamellar number is not understood. This is a topic which deserves much exploration, but which is outside the purview of the present paper. It suffices here to demonstrate that in this, as in other features, anoles show a wide spectrum of conditions and that use of toe structure as a generic character illuminates neither the phyletic nor the functional aspects of a complex situation.

SUBDIVISION OF THE GENUS *ANOLIS:* DISCUSSION.

It seems quite clear that neither gular nor toe modifications in anoles provide a clear basis for generic distinctions. Indeed, except for the head-crest characters utilizable in the recognition of the genera *Phenacosaurus* and *Chamaeleolis*, I know of *no* external characters that do furnish valid grounds for subdivision of anoles. If the huge genus *Anolis* is to be split, it will probably be on osteological or other internal features.

The first attempt at an analysis on osteological features has

been made by Etheridge. It is very unfortunate that his studies have not yet been formally published since they are in many regards highly successful.

Thus I call attention to the possibility that Etheridge's alpha and beta sections might usefully be recognized as genera. *Anolis* Daudin 1803 (type: *Anolis bullaris* Daudin 1803 [= *Anolis carolinensis* Voigt] by subsequent selection of Stejneger, 1904) will serve for the alpha section, and *Norops* Wagler 1830 (type by monotypy *auratus* Daudin 1803) for the beta section. An inconvenience of such an arrangement which will distress some herpetologists is the total absence of any external recognition marks for these putative genera. Etheridge's arrangement would, however, be a natural one and, as such, welcome, despite this trivial inconvenience. More pertinent is the objection that such a division in no substantial way alleviates the unwieldly nature of the currently recognized genus. *Anolis* now is so large that to cut its dimensions by only half is hardly a noteworthy contribution. It may be best, for the present, to bear with the very large genus *Anolis* until knowledge of many sets of characters make its subdivision into more manageable units practicable and secure.

ACKNOWLEDGMENTS

I am very much indebted to Miss A. G. C. Grandison, Dr. Doris Cochran, Dr. J. E. Böhlke, Dr. Norman Hartweg, Dr. Robert Inger, and Mr. C. M. Bogert for the privilege of examining material under their care. National Science Foundation grant NSF G 16066 has generously supported the studies of which this is a part.

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TABLE 2

Toe lamellae in large anoles[1]

	Snout-vent length	*lamellae 4th toe*	*lamellar index*
WEST INDIES			
equestris (MCZ 46203)	164	48	*29*
ricordii (MCZ 68479)	148	35	*24*
cuvieri (MCZ 58898)	135	32	*24*
roosevelti (MCZ 36138)	155	31	*20*
Chamaeleolis chamaeleontides (MCZ 59331)	161	31	*19*
vermiculatus (Boulenger 1885)	117	30	*26*
bimaculatus (MCZ 10398)	99	33	*33*
leachii (MCZ 16167)	100	31	*31*
ferreus (MCZ 28547)	96	31	*32*
richardii (MCZ 8117)	106	26	*24*
garmani (MCZ 7360)	104	31	*30*
SOUTH AMERICA			
fraseri (ANSP) 25563)	128	22	*17*
latifrons (MCZ 16789)	124	24	*19*
princeps (Vienna 12817)	124	22	*19*
squamulatus (UMMZ 123390)	116	23	*20*
mirus (BM type)	105	15	**14**
apollinaris (BM type)	106	25	*23*
CENTRAL AMERICA			
insignis (MCZ 15439)	126	25	*20*
microtus (MCZ 15424)	106	21	*20*
petersi (MCZ 57277)	109	28	*26*
loveridgei (MCZ 38832)	103	29	*28*
biporcatus (MCZ 22296)	85	22	*26*
capito (MCZ 15438)	83	16	*19*
barkeri (MCZ 58221)	86	16	*18*

$$\text{Lamellar index} = \frac{\text{lamellar number}}{\text{snout-vent length}} \times 100$$

[1] All are the genus *Anolis* as here understood, except *Chamaeleolis*. Abbreviations used: ANSP — Academy of Natural Sciences of Philadelphia; BM — British Museum (Natural History); UMMZ — University of Michigan Museum of Zoology; Vienna — Naturhistorisches Museum, Wien.

Figure 2. Lateral view of *Anolis mirus* new species, Type BM 1910.7.11.5.

Figure 3. Lateral view of *Anolis fraseri* Günther ANSP 25563.

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AMERICAN SPIDERS OF THE GENUS *THERIDION* (ARANEAE, THERIDIIDAE)

BY HERBERT W. LEVI

WITH THIRTEEN PLATES

CAMBRIDGE, MASS., U.S.A.

PRINTED FOR THE MUSEUM

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No. 10 — *American Spiders of the Genus* Theridion (*Araneae, Theridiidae*)

By Herbert W. Levi

It was not originally my intention to write an exhaustive revision of South American theridiid spiders, and the publication of the present revisions came about as a by-product of a trip to Europe in 1958 to study the type species of theridiid genera. During the trip I found extra time to study the holotypes of the numerous South American theridiid species, especially desirable as many of the oldest American spider names are for South American species. Further, it had been learned that the distribution of some North American species is far wider than previously thought, so that the names of some South American species might have to be applied to species from North America. At the time the holotypes were examined I made careful genitalia drawings, but usually no descriptions, as those found in the literature were thought to be adequate and time was short. On my return to the United States I considered publishing the genitalia drawings, but numerous questions arose: males could not be matched with females; distributions were unknown; geographic variation remained unknown. Thus one could not be certain whether two similar holotypes from different localities belonged to the same species or not. Clearly, it was necessary to borrow some collections, but while very large collections were obtained, they did not come from all parts of South America. There were few from Colombia, few from central and eastern Brazil, and hardly any from Argentina. I thought it most important to examine collections from areas from which theridiid species had been described during the 19th century: the Guianas, Peru, and southeastern and southern Brazil and Chile. While most of the old species were rediscovered in the collections, each collection seemed to create new problems of more new species and unmatched sexes. This paper, like my other revisions of South American spiders, is thus very incomplete. Probably less than ten per cent of the species of the large genus *Theridion* are known. I hope that most of the common theridiid species are described and figured, but it is unfortunate that several sketchily described South American *Theridion* species, whose types are in Brazil and whose genitalia remain unfigured, could not be examined. Several older types, mostly those kept in the Berlin Museum, could not be located.

Like my other papers dealing with the South American theridiid spiders, this one is unavoidably uneven in treatment of species. The papers were prepared over a period of four years. Some species were described or illustrated from only one specimen, the holotype in a European museum. Large numbers of specimens of some other species were available. Some collections were examined one after another over a period of four years, while only the largest collections (those of the American Museum of Natural History and the Muséum National d'Histoire Naturelle, Paris, thanks to the patience of Dr. W. J. Gertsch and Prof. M. Vachon, and that of the Museum of Comparative Zoology) remained available continuously for comparison. Though during these four years the optical equipment available to me has vastly improved, species represented by single individuals could be examined only superficially. Specimens from large series could be dissected and temporary microscope slides were made. Old types were often in poor physical condition, covered with cork precipitates that are difficult to remove. Several specimens suspected to be new were not described because it seemed better to wait until additional specimens became available in order to show the diagnostic characters.

Many of the 19th century type localities mentioned in this paper are difficult or impossible to find on today's maps. In a separate paper (in press) the old type localities are listed and mapped.

Bonnet (1961) indicated that the second largest genus of spiders is *Theridion*, with 625 species in 1938. However, some of the species in Bonnet have been transferred to the large genus *Achaearanea* Strand, first recognized as distinct by Keyserling as *Achaea;* others have to be transferred to *Chrysso* O.P.-Cambridge, with its numerous South American species. *Anelosimus*, first recognized by Simon as distinct, and also having numerous species, is the genus to which the majority of Chilean theridiid spiders belong. It was later synonymized by Simon. A fourth separated genus is *Thymoites*, containing many small species; relatively few *Thymoites* are known from South America, presumably because collectors have concentrated on the larger species. The genus *Thymoites* was first used by Keyserling for a single Peruvian species. Simon later described *Sphyrotinus* (now considered a synonym of *Thymoites*) from the Lesser Antilles, but placed others allied to the genus into *Theridion*. *Thymoites* has numerous synonyms; in the majority of species the male

has erigonid-like modifications in the eye or clypeus region of the carapace. Even the small genus *Colcosoma* O. P.-Cambridge had been considered a synonym by some earlier cataloguers until the late Miss Bryant pointed out its distinctness.

Of the genera, *Anelosimus* is most distinct. *Achacaranea* and *Colcosoma* are very distinct, but have many species of which males are necessary for accurate generic placement. *Chrysso* and *Thymoites,* however, are believed to be specialized offshoots of *Theridion,* and the placement of some species may be arbitrary (Levi and Levi, 1962).

The number of species remaining in *Theridion* may still make it the second largest genus of spiders. As mentioned above, I suspect that only a minority of American species are known, many species being rare. (This may also be true for *Achacaranea* and *Chrysso,* certainly for *Thymoites.*) The majority of the American *Anelosimus* and *Colcosoma* may be known; these are genera whose species are common and widespread. But *Theridion* in addition to being the largest theridiid genus, is also the most diverse. Only a portion of species can be placed into species-groups, and only if males are on hand. That the skilled and experienced arachnologist Simon had to synonymize previously described theridiid genera with *Theridion* because he could not recognize differences, and by his own admittance had to use characters he believed artificial, points to the great difficulties in finding adequate characters for separating groups. The characters to be used are those of genitalia. Strong spines are not usually present in the theridiids. The eye arrangement and size may be variable (Levi, 1960). The coloration, often a prominent feature, may be different, as in some species of *Dipoena,* or it may be similar in species groups (*Theridion murarium* group), or in some *Theridion* species (and Chilean *Anclosimus*) no two specimens have the same coloration. Also, coloration readily changes in alcohol. *Latrodectus* loses its red marks and some *Theridion* species, alleged to be green, appear colorless. The problem of generic and phylogenetic characters has been discussed in two previous papers (Levi, 1961; Levi and Levi, 1962). Despite vast (but often superficial) differences in genitalia, I have been unable to separate any other groups from the genus *Theridion.* But as mentioned before (Levi and Levi, 1962), large genera are in general easier to work with than small ones, so it may not be desirable to split *Theridion* further by characters that may have doubtful phylogenetic significance.

Only genitalic structure presents reliable characters for species groups and species, and has been used almost exclusively for keys to the known American species. This does not result in the simplest keys, but no other solution to the problem of separating species groups and species was found.

Like my other papers on South American theridiid spiders, this would have been impossible without the assistanee of a grant from the National Science Foundation (G-4317), making possible a trip to European museums, and a grant from the National Institutes of Health (E-1944), providing suffieient help to examine collections and complete the manuscripts. Nor could the paper have come about without the help in form of adviee, hospitality, and specimens from numerous individuals and institutions. For such help I would like to thank Dr. W. J. Gertsch of the American Museum of Natural History (AMNH); Prof. M. Vachon, Muséum National d'Histoire Naturelle, Paris (MNHN); Mrs. D. Frizzell (Dr. H. Exline) of Rolla, Missouri; and Dr. E. S. Ross of the California Academy of Sciences (CAS); Dr. G. Owen Evans; Mr. E. Browning; Mr. K. Hyatt; and Mr. D. Clark of the British Museum (Natural History) (BMNH); Prof. G. C. Varley of the Hope Department of Entomology, Oxford University; Dr. A. Riedel and Mr. J. Prószyński of the Polish Academy of Sciences (PAS); Dr. A. Collart and Mr. J. Kekenbosch of the Institut Royal des Sciences Naturelles, Brussels (ISNB); Dr. O. Kraus, Senckenberg Museum, Frankfurt (SMF) and Dr. W. Engelhardt of the Zoologische Sammlungen des Bayerischen Staates (ZSM); Prof. M. Birabén of the Museo de la Plata and Museo Argentino de Ciencas Naturales, Buenos Aires; Dr. P. E. Vanzolini and Mr. P. de Biasi of the Departamento de Zoologia, Secretaria da Agricultura, São Paulo; and Dr. J. V. Scorza, Universidad Central, Caracas. I am grateful to Fr. Chrysanthus for help with Latin names.

Theridion Walckenaer

Theridion Walckenaer, 1805, Tableau des Aranéides, p. 72. Type designated by Internatl. Comm. Zool. Nomen. Opinion 517, 1958: *Aranea picta* Walckenaer, 1802. *Theridion* is listed in the official list of Generic Names in Zoology, name no. 1272 and the subsequent invalid emendations *Theridium* Leach, 1824, and *Theridio* Simon, 1864, are listed in the Official Index of Rejected and Invalid Generic Names in Zoology, no. 1159, 1160, Opinion 517, 1958.

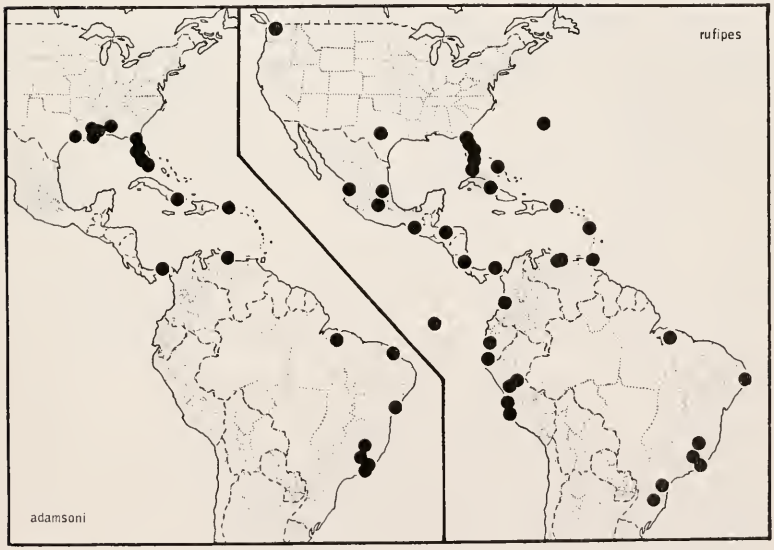
Diagnosis. Carapace as wide as long, or longer than wide without modification (such as grooves or projections) in eye

region or clypeus. Chelicerae with no teeth, or one to two teeth on anterior margin, none posterior. Males may have chelicerae elongate or with anterior proximal boss. First leg longest, second leg next in males, fourth leg next in females, third leg shortest. Abdomen oval, subspherical, sometimes wider than long. No colulus present.

Epigynum variable. Palpus with median apophysis (M in Figs. and keys), conductor (C), embolus (E), and radix (R).

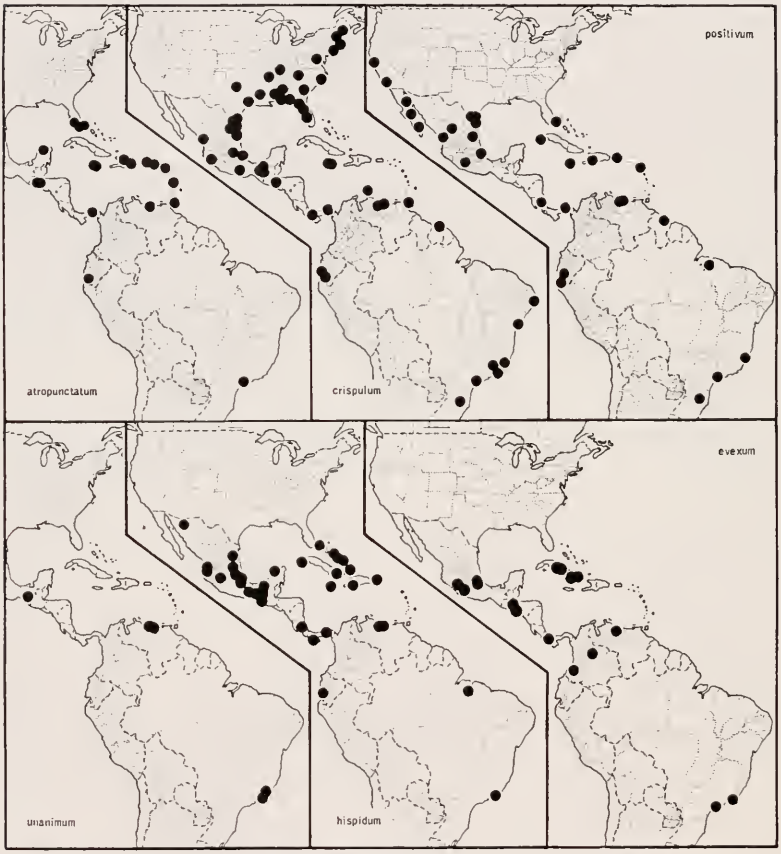
Separated from *Chrysso, Coleosoma, Tidarren, Achaearanea* by having abdomen suboval to wider than long; from *Achaearanea* and *Tidarren* by having the cymbium only rarely extended beyond alveolus; from *Achaearanea* by having a radix (only rarely, secondarily, absent) and a free median apophysis in the palpus; from *Tidarren* by having two palpi; from *Thymoites* by generally larger size, longer legs and by never having the eye region of the male carapace modified. It is sometimes difficult to recognize unaccompanied females of *Theridion* and related genera that lack the colulus (Levi and Levi, 1962).

Distribution. Cosmopolitan with several hundred species. Comments on the distribution of North American species are found in the previous papers and distribution maps (Levi, 1957, 1959).



Map 1. American distribution of two cosmotropical *Theridion*.

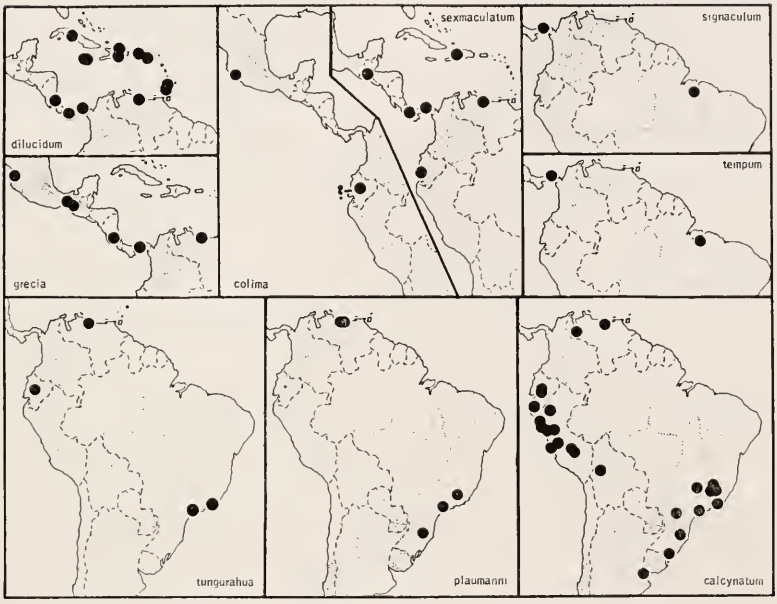
Either the South American *Theridion* are rare, or the range of the vast majority of species is restricted, or both. Exceptions are the two cosmopolitan species, *T. adamsoni* and *T. rufipes* (Map 1), and the following (Maps 2, 3):



Map 2. Distribution of some widespread South American *Theridion*.

T. crispulum from Nova Scotia to southern Brazil
T. atropunctatum from Florida to southern Brazil
T. positivum from southern United States to Paraguay
T. evexum and *T. unanimum* from Mexico to southern Brazil
T. calcynatum from Venezuela to Argentina
T. plaumanni and *T. tungurahua* from Venezuela to southern Brazil

T. signaculum and *T. tempum* from Panama to northern Brazil
T. hispidum from Mexico and West Indies to Paraguay
T. grecia from Mexico to Venezuela
T. colima from Mexico to Ecuador
T. dilucidum from West Indies, Central America and Venezuela
T. sexmaculatum from West Indies and Central America to Ecuador



Map 3. Distribution of some widespread South American *Theridion*.

None of these wide ranging species occurs in Chile, which seems to have its own surprisingly poor endemic fauna of only four species of *Theridion* (one of them also found in southern Argentina). Large collections were examined from Chile.

Five species are known from Central America to Ecuador or Peru, two from Central America to Venezuela (*costaricaense, marvum*), and three additional ones from Venezuela to Ecuador or Peru (*frizzellorum, volubile, iramon*). Eleven species are known only from Venezuela and Colombia; twenty-two species from Peru and Ecuador, with only two that appear to be common to Ecuador and northern Peru; five species in the Guianas and northern and eastern Brazil; thirty-four from southeastern

Brazil to northern Agentina; and two from Bolivia.

Misplaced species from South America.

T. acoreensis Berland, 1932 = *Achaearanea acoreensis* (Berland)

T. agreste Nicolet, 1849 = *Episinus typicus* (Nicolet)

T. alacre Keyserling, 1884 = *Achaearanea alacre* (Keyserling)

T. albolineatum Nicolet, 1849 = *Anelosimus albolineatus* (Nicolet)

T. albovittatum Caporiacco, 1955 = *Coleosoma floridanum* Banks

T. ancoratum Holmberg, 1876 = *Steatoda ancorata* (Holmberg)

T. attritum Nicolet, 1849 = *Anelosimus attritus* (Nicolet)

T. bäckströmi Berland, 1924 = *Chrysso backstromi* (Berland)

T. bellulum Keyserling, 1891 = *Achaearanea bellula* (Keyserling)

T. bentificum Keyserling, 1891 = *Achaearanea hirta* (Taczanowski)

T. bicorne Keyserling, 1891 = *Episinus bicorniger* (Simon)

T. bituberculatum Keyserling, 1884 = *Episinus immundus* (Keyserling)

T. boqueronicum Kraus, 1955 = *Achaearanea nigrovittata* (Keyserling)

T. bucculentum Nicolet, 1849 = *Anelosimus bucculentus* (Nicolet)

T. cambridgei Petrunkevitch, 1911 = *Chrysso vittata* (O. P.-Cambridge)

T. caracasanum Simon, 1895 = *Thymoites caracasanus* (Simon)

T. cidrelicola Simon, 1894 = *Lucarachne cidrelicola* (Simon), SYMPHYTOGNATHIDAE

T. citrinum Taczanowski, 1894 = *Nesticus citrinus* (Taczanowski), NEW COMBINATION

T. conspersa, — Simon, 1894 = *Chrysso compressa* (Keyserling)

T. dromedariforme Roewer, 1942 = *Achaearanea dromedariforma* (Roewer)

T. dubiosum Keyserling, 1891 = *Anelosimus dubiosus* (Keyserling)

T. emendatum Roewer, 1942 = *Chrysso albomaculata* O. P.-Cambridge

T. ethicum Keyserling, 1884 = *Anelosimus ethicus* (Keyserling)

T. eximium Keyserling, 1884 = *Anelosimus eximius* (Keyserling)
T. fasciatum Holmberg, 1876 = *Anelosimus studiosus* (Hentz)
T. fordum Keyserling, 1884 = *Tidarren fordum* (Keyserling)
T. fuegianum Simon, 1904 = *? Anelosimus australis* (Simon)
T. gibbithorax Simon, 1894 = *Thymoites gibbithorax* (Simon)
T. giganteum Keyserling, 1884 = *Achaearanea gigantea* (Keyserling)
T. gracile Keyserling, 1884 = *Anelosimus gracilis* (Keyserling)
T. gymnasticum Keyserling, 1884 = *Anelosimus ethicus* (Keyserling)
T. haemorrhoidale Bertkau, 1880. Type from Rio de Janeiro, lost, probably = *Tidarren fordum* (Keyserling)
T. immundum Keyserling, 1884 = *Episinus immundus* (Keyserling)
T. interruptum Banks, 1908 = *Coleosoma floridanum* Banks
T. jucundum O. P.-Cambridge, 1896 = *Anelosimus jucundus* (O. P.-Cambridge)
T. keyserlingi Petrunkevitch, 1911 = *Chrysso nigriceps* Keyserling
T. leguiai Chamberlin, 1916 = *Achaearanea leguiai* (Chamberlin)
T. levipes Nicolet, 1849 = *Anelosimus attritus* (Nicolet)
T. lobifrons Simon, 1895 = *Thymoites lobifrons* (Simon)
T. maculosum Keyserling, 1884. Type in the Institut Royal des Sciences Naturelles, Brussels, examined, in poor condition, probably = *Tidarren fordum* (Keyserling, 1884). NEW SYNONYMY.
T. magnificum Keyserling, 1884 = *Anelosimus studiosus* (Hentz)
T. michaelseni Simon, 1902 = *Anelosimus michaelseni* (Simon)
T. migrans Keyserling, 1884 = *Achaearanea migrans* (Keyserling)
T. minusculum Nicolet, 1849 = *Anelosimus attritus* (Nicolet)
T. nigrescens Keyserling, 1884 = *Anelosimus ethicus* (Keyserling)
T. nigrovittatum Keyserling, 1884 = *Achaearanea nigrovittata* (Keyserling)
T. notabile Keyserling, 1891 = *Euryopis notabile* (Keyserling)

T. obnubilum Keyserling, 1891 = *Achaearanea nigrovittata* (Keyserling)
T. pallipes Keyserling, 1891 = *Achaearanea pallipera* Levi
T. passivum Keyserling, 1891 = *Achaearanea passiva* (Keyserling)
T. perniciosum Keyserling, 1886 = *Paratheridula perniciosa* (Keyserling)
T. picadoi Banks, 1909 = *Achaearanea tesselata* (Keyserling)
T. pingue Keyserling, 1886 = *Achaearanea pingue* (Keyserling)
T. puer Mello-Leitão, 1941 = *Thymoites puer* (Mello-Leitão)
T. pussilanum Roewer, 1942 = *Achaearanea pussilana* (Roewer)
T. pusillum Keyserling, 1884 = *Achaearanea pussilana* (Roewer)
T. quadripartitum Keyserling, 1891 = *Achaearanea quadripartita* (Keyserling)
T. rarum Keyserling, 1886 = *Thymoites rarus* (Keyserling)
T. recurvatum Tullgren, 1901 = *Anelosimus recurvatus* (Tullgren)
T. rotundum Keyserling, 1891 = *Chrysso nigrosternum* Keyserling
T. rubellum Keyserling, 1884 = *Dipoena rubella* (Keyserling)
T. rubicundulum Roewer, 1942 = *Chrysso vexabilis* Keyserling
T. salvadorense Kraus, 1955 = *Achaearanea taeniata* (Keyserling)
T. signatellum Roewer, 1942 = *Chrysso pulchra* (Keyserling)
T. sordidum Holmberg, 1876 = *Anelosimus studiosus* (Hentz)
T. spinatum Tullgren, 1901 = *Anelosimus australis* (Simon)
T. splendens Roewer, 1942 = *Chrysso vittata* (O. P.-Cambridge)
T. struthio Simon, 1895 = *Thymoites struthio* (Simon)
T. taeniatum Keyserling, 1884 = *Achaearanea taeniata* (Keyserling)
T. tesselatum Keyserling, 1884 = *Achaearanea tesselata* (Keyserling)
T. tosum Chamberlin, 1916 = *Anelosimus jucundus* (O. P.-Cambridge)
T. typicum Nicolet, 1849 = *Episinus typicus* (Nicolet)
T. utibile Keyserling, 1884 = *Echinotheridion utibile* (Keyserling)
T. variipes Keyserling, 1884 = *Steatoda variipes* (Keyserling)

T. vividum Keyserling, 1891 = *Achaearanea vivida* (Keyserling)

Unrecognizable species. Nicolet, 1849, described numerous species of *Theridion* all differentiated by coloration: *armatum, concinnum, funerarium, liliputanum, ocellatum, onustum, opimum, purpureum, roseum, rubicundum, silvestre, spinipes, superbum, transversum, umbrosum, ventrosum, virgulatum, viride, vittatum.* The names are believed to be synonyms of the recognizable Nicolet species, mostly those of the genus *Anclosimus*, which are variable in color. Roewer, 1942, gave new names to two of Nicolet's unrecognizable ones, *gayi* for *vittatum, viridulum* for *viride*, because he considered them preoccupied.

In addition, the following names are unrecognizable including some of Hingston. Extensive inquiry in British museums revealed that Hingston left no type specimens for his species which have no diagnostic characters.

T. adspersum Perty, 1833, Delect. Anim., p. 193, pl. 38, fig. 6, ♀ from Bahia, Brazil. Type formerly with the Zoologische Sammlungen des Bayerischen Staates, Munich; lost; probably destroyed.

Theridion brasilianum Keyserling, 1884, Die Spinnen Amerikas, Theridiidae, 2(1): 81, pl. 4, fig. 50, ♀. Female holotype from Brazil in the Berlin Museum, apparently lost. Göldi, 1892, Mitt. Osterlande, neue Folge, 5: 213. Göldi (1892) records the species from Rio de Janeiro.

T. conifaciens Hingston, 1932, Naturalist in Guiana Forest, p. 375. Probably *nomen nudum* from Br. Guiana; no types in existence.

T. coniferum Blackwall, 1862, Ann. Mag. Nat. Hist. (3)10: 429. Type not in Hope Department of Entomology, lost. Probably belonging to *Achaearanea.*

T. moraballii Hingston, 1932, Naturalist in Guiana Forest, p. 376, probably *nomen nudum.* From Br. Guiana. No types in existence. Bonnet, 1959, Bibliographia Araneorum, 2: 4492, has changed the name to *T. moraballicum.*

T. rubrolineatum Taczanowski, 1874, Horae Soc. Ent. Rossicae 10: 58, from French Guiana. Type lost.

Species not available for examination. Neither of the two Mello-Leitão descriptions gives diagnostic characters or illustrates genitalia.

T. fidum Mello-Leitão, 1943, Arq. Mus. Nac., 37: 169, figs. 13, 14. Female and male syntypes from Rio Grande do Sul in the

Museu Nacional, Rio de Janeiro unavailable. The illustration indicates that this may be a linyphiid.

T. melanosternum Mello-Leitão, 1947, Arq. Mus. Paranaense, 6: 237, figs. 4, 5, ♀. Female type from Bariguí, Município de Curitaba, Paraná, Brazil in the Museu Paranaense, unavailable for examination.

Additional records and notes on United States and Canadian species. In addition to the three new southwestern species (*T. aeolium*, *T. cochise*, *T. yuma*) described in this paper, the following changes or additions have to be made to the earlier *Theridion* revision (Levi, 1957).

Theridion adamsoni Berland, 1935 (= *T. hobbsi* Gertsch and Archer, 1942)

T. antonii Keyserling, 1884, *Virginia*. Shenandoah National Park

T. crispulum Simon, 1895 (= *T. intervallatum* Emerton, 1915) *Nova Scotia*. Coldbrook, Aldershot (C. Dondale)

T. istokpoga Levi, 1957. *Alabama*. Baldwin Co.: Bear Point (A. F. Archer)

T. llano Levi, 1957. *Missouri*. Johnson Co.: Warrensburg (W. Peck).

T. lowrici Barrows, 1945. Female type in the collection of Ohio State University; microscope slide with genitalia lost.

T. lyricum Walckenaer, 1841. *Nova Scotia*. Kentville (C. Dondale)

T. montanum Emerton 1882. *Arizona*. Baldy Peak, White Mountains, 2700 m, June 1936 (E. D. Ball)

T. morulum O. P.-Cambridge, 1898 (= *T. jeanae* Gertsch and Archer, 1942)

T. pennsylvanicum Emerton, 1913. *Ohio*. Erie Co.: Resthaven Refuge, July 1959, ♂ (J. Beatty)

T. petrense Sørensen, 1898. *New Hampshire*. Coos Co.: Mt. Washington, "corn pasture," 1500 m, July 1920, ♀ (J. H. Emerton)

T. pictum (Walckenaer), 1802 (= *T. ornatum* Hahn, 1831)

T. sardis Chamberlin and Ivie, 1944. (not *T. sarde*, — Levi, 1958)

T. sexpunctatum Emerton, 1882. *Nova Scotia*. Kentville (C. Dondale) *Colorado*. Gunnison Co.: Gothic, 2900 m, Elk Mts. (W. J. Gertsch, V. Roth, H. Levi)

Additional records and notes on Mexican, Central American and West Indian species. The following corrections and additions have to be made to the earlier revision (Levi, 1959). "Port Grillo or Port Grila," according to a letter by A. M. Nadler, the collector, does not exist and must be a mistake in transcribing Puerto Rico. The following new species are here described from the area.

T. amatitlan from Guatemala
T. baltasarense from Lesser Antilles
T. costaricaense from Central America
T. cuyutlan from Colima, Mexico
T. dominica from the Lesser Antilles
T. hassleri from Dominican Republic
T. michcneri from Panama
T. nesticum from Trinidad
T. opuntia from Sonora, Mexico
T. pelaezi from Puebla, Mexico
T. schrammeli from San Luis Potosí, Mexico
T. stannardi from Chiapas, Mexico

Redescribed here are:

T. cocosense Strand from the Coco Islands, Costa Rica
T. unanimum Keyserling, 1891 (= *T. quemadum* Levi, 1959)

Additions to the known range

T. dotanum (Banks), 1913. *Dominican Republic.* San Domingo, 3 March 1955, small ♂ (A. M. Nadler)
T. lathropi Levi 1959. *Costa Rica* (SMF)

Further comments on the following are found in the text below:

T. armouri, T. artum, T. atropunctatum, T. dilucidum, T. hispidum, T. positivum, T. rufipes, T. sexmaculatum.

Keys to American species. The keys are mainly based on genitalia for reasons discussed in the introduction. They should be used together with the illustrations in this paper and the two previous papers on American *Theridion* (Levi, 1957, 1959). They are divided into keys for Canadian and United States species, which are fairly well known, and keys for the species of Mexico, Central America, the West Indies and South America.

Key to Female *Theridion* of Canada and the United States

(Abbreviations: SR, seminal receptacles; CD, connecting ducts); Figures capitalized refer to the present paper; figures in lower case (figs.) to Levi 1957 unless otherwise stated.

1a. Epigynum with a central hump or boss 6
1b. Epigynum flat, depressed, with an elevated plate or with two humps 2
2a. Epigynum with a single central depression, containing two circular or slit-like openings, openings readily apparent; or with a central depression divided by a septum 9
2b. Epigynum otherwise, if with a central depression, duct openings not visible in ventral view 3
3a. Epigynum with a pair of separate depressions or openings or dark spots 20
3b. Epigynum with only one depression, or no depression 4
4a. Epigynum with a central depression, opening or central dark spot 33
4b. Epigynum without a central depression or opening 5
5a. Epigynum with no apparent sclerotized parts, indistinct 66
5b. Epigynum otherwise 73
6a. Epigynum with an elevated dark area anterior to openings (fig. 94); Utah ..... *timpanogos*
6b. Epigynum with openings in dark elevated area or openings not visible 7
7a. Hump some distance from margin, hemispherical (figs. 191-193); cosmotropical ..... *rufipes*
7b. Hump or sclerotized area touching margin; western U. S. 8
8a. Apex of hump close to margin (figs. 269, 275) ..... *neomexicanum*
8b. Apex of hump away from margin (figs. 273, 277) ..... *californicum*
9a. Depression of epigynum longer than wide, openings slits (fig. 248); Gulf states ..... *istokpoga*
9b. Depression wider than long, circular, or if longer than wide, openings circular 10
10a. Abdomen subtriangular with a slight tubercle above spinnerets (figs. 354, 357), epigynum (fig. 356); southeastern states ..... *cheimatos*
10b. Abdomen oval to subtriangular, no tubercle above spinnerets 11
11a. Depression of epigynum circular or longer than wide 12
11b. Depression wider than long 13
12a. Depression subcircular; a keel on narrow posterior margin; openings slits (fig. 178); British Columbia, Washington ..... *varians*
12b. Depression circular or longer than wide; openings circular, closer to each other than to margin of depression (figs. 84, 86); widespread ..... *rabuni*
13a. Circular openings widely separated partly hidden by margins of depression 14
13b. Openings not close to margin, or if close separated by narrow septum only 15
14a. Depression twice as wide as long (fig. 212); Washington, Oregon ..... *tinctum*
14b. Depression less than one and one-half times as wide as long (fig. 208); widespread ..... *alabamense*
15a. Abdomen wider than long (figs. 245-246); Texas, California *positivum*
15b. Abdomen longer than wide or subspherical 16

16a. A faint septum in anterior of depression (figs. 119, 347, 352) ..... *kawea, sexpunctatum, aurantium*

16b. Epigynum otherwise 17

17a. Openings near center; septum reaching only two-thirds the way to anterior margin, branching, continuing as anterior margin of openings (fig. 214); cosmotropical ..... *adamsoni*

17b. Epigynum otherwise 18

18a. Openings in anterior coils of depression margins (1959, fig. 92); Arizona ..... *gertschi*

18b. Both openings together filling depression, septum narrow (figs. 219-221); eastern states 19

19a. SR spherical (figs. 215-216), coloration light, leg bands indistinct ..... *antonii*

19b. SR oval (figs. 217-218); coloration dark, legs with bands ..... *punctosparsum*

20a. Openings of epigynum hidden in ventral view, seen from posterior only (figs. 108, 109); southeastern states ..... *flavonotatum*

20b. Openings or spots visible in ventral view 21

21a. Openings two dark, circular disks, about three diameters apart; CD looping anterior of disks (fig. 63); widespread ..... *murarium*

21b. Openings, CD otherwise 22

22a. Epigynum with two dark subcircular spots; epigynum not a raised plate; western states (figs. 266, 268) 23

22b. Epigynum not with two dark spots; or if with spots, spots on a raised plate 24

23a. Posterior median eyes three-quarters diameter apart, one diameter from laterals ..... *punctipes*

23b. Posterior median eyes one diameter or more apart, one diameter or more from laterals ..... *lecchi*

24a. Openings a pair of dark confluent spots on an elevated plate (fig. 256); Canada, northern states and Rocky Mountains ..... *montanum*

24b. Openings not a pair of dark spots on a plate 25

25a. Openings of epigynum two dark adjoining pits without distinct margins (fig. 105); spider reddish color; widespread ..... *differens*

25b. At least part of margin of opening distinct or sclerotized 26

26a. Two openings in a common heavily sclerotized area (fig. 283); Greenland to Alberta ..... *petrense*

26b. Two openings not in a common heavily sclerotized area 27

27a. Openings their diameter apart, their posterior and side sclerotized; openings their length from genital groove (fig. 115; 1959, fig. 75); Texas ..... *cameronense*

27b. Openings otherwise 28

28a. Distinct circular openings, their diameter or less apart (fig. 156); one-third their diameter from genital groove 29

28b. Openings otherwise 30

29a. CD coiled; SR spherical (fig. 155); eastern provinces, states ..... *glaucescens*

29b. CD large loops; SR dumbbell-shaped (fig. 126); Texas ... *cynicum*
30a. Openings with anterior and median margins sclerotized, two or more diameters apart, ducts relatively short (*pennsylvanicum* group); eastern states ... 31
30b. Openings otherwise, usually closer together, usually difficult to see .. 66
31a. Openings leading into sclerotized sacs whose axis is parallel to margin; CD straight (figs. 318, 319) ... *neshamini*
31b. Axis of sacs not parallel to margin; CD elbowed ... 32
32a. Sacs elbowed (fig. 315); heavily sclerotized ... *orlando*
32b. Sacs straight (fig. 313) ... *pennsylvanicum*
33a. Epigynum with a wider than long dark spot on an elevated plate (fig. 258); western states ... *lawrencei*
33b. Epigynum otherwise ... 34
34a. Abdomen wider than long ... 35
34b. Abdomen spherical or longer than wide ... 36
35a. CD openings on sides of depression (figs. 232-234); southern Florida ... *atropunctatum*
35b. CD openings on posterior margin of depression (figs. 230-231); Atlantic, Pacific Coast and southeastern states ... *crispulum*
36a. Epigynal depression with a V-shaped mark (figs. 333, 334); Canada and western states ... *ohlerti*
36b. Epigynal depression without a V-shaped mark ... 37
37a. Depression with a pair of small sclerotized lobes in anterior-lateral border (fig. 330); eastern provinces, states ... *lyricum*
37b. Depression without such lobes on margin ... 38
38a. A swelling on each side of depression; depression containing dark mark (Figs. 96, 97); Arizona ... *aeolium*
38b. Epigynum otherwise ... 39
39a. Epigynum with a central dark area or a sclerotized plate ... 40
39b. Epigynum without a central sclerotized plate ... 43
40a. Dark area longer than wide (fig. 76); southeastern states ... *dulcineum*
40b. Dark area circular or wider than long ... 41
41a. Dark area a greater distance than its width from genital groove; ducts leaving posteriorly (fig. 279); southeastern states ... *pictipes*
41b. Dark area closer to genital groove; head portion of carapace black .. 42
42a. A central plate with an inverted V-shaped dark mark (fig. 96); Florida ... *myersi*
42b. A central plate, without such mark but with duct coiling posterior-lateral to dark area (fig. 73) ... *dividuum*
43a. A carina between depression and margin; depression more than three times its width from groove ... 44
43b. No carina between depression and margin; or if carina present, depressions less than three times their width from margin ... 45
44a. Carina close to genital groove (fig. 170); Canada, northern states ... *pictum*

44b. Carina almost half-way between genital groove and depression (fig. 172); widespread ..... *berkeleyi*
45a. Depression circular or longer than wide 46
45b. Depression wider than long 48
46a. Depression without anterior margin; lateral margins parallel (fig. 78); Missouri, Texas ..... *llano*
46b. Depression with anterior margin; or if without, margins not parallel 47
47a. Depression its width from genital groove (fig. 92); California ..... *cowlesae*
47b. Depression almost touching genital groove (fig. 184); western states ..... *melanurum*
48a. Depression its length or more from margin 49
48b. Depression less than its length from genital groove 55
49a. Depression with a dark, longer than wide stripe behind, branching near margin (fig. 76); southeastern states ..... *dulcineum*
49b. Depression otherwise 50
50a. Depression with a subcircular dark spot on each lateral margin (fig. 268); western states ..... *leechi*
50b. Depression without lateral spots; or if lateral spots, not western 51
51a. Depression without posterior margin (fig. 158); southwestern states ..... *transgressum*
51b. Depression with posterior margin 52
52a. Depression its width or less from posterior margin (fig. 119); southwestern states ..... *kawea*
52b. Depression more than its width from posterior margin 53
53a. An oval dark area on each side of depression (fig. 287); eastern provinces and states ..... *albidum*
53b. Whole area between depression and genital groove dark 54
54a. Usually with a dark patch on each side above depression (fig. 285); Pacific Coast only ..... *agrifoliae*
54b. Without such dark patches (fig. 289); eastern provinces and states, rare in west ..... *frondeum*
55a. Depression with a dark notch at posterior border, otherwise border not sclerotized (fig. 138); southwestern states ..... *arizonense*
55b. Depression without a dark notch on posterior border 56
56a. Depression lacking anterior border 57
56b. Depression with anterior border 61
57a. Border of sides of depression curled anterior (1959, fig. 92); Arizona ..... *gertschi*
57b. Border not curled anterior 58
58a. Depression at least twice as wide as long, its length from margin (fig. 180); British Columbia, Washington ..... *simile*
58b. Depression narrower, and touching margin 59
59a. CD with anterior loop (1959, figs. 89, 90); southwestern states ..... *submissum*
59b. CD without anterior loop 60

60a. CD opening on sides of depression (fig. 348); Alaska, northern states, Appalachian and Rocky Mts. ..... *sexpunctatum*

60b. CD opening towards anterior (fig. 352); Alaska, northern states ..... *aurantium*

61a. Depression on a raised area, a CD loop usually visible on each side (always in cleared specimens). Openings of ducts at anterior border of depression (figs. 64-66); northern, western states ..... *petraeum*

61b. Duct without loop on each side of depression; or if loop shows, openings are at posterior border of depression 62

62a. Depression heavily sclerotized; entirely black (fig. 281); Southwest .. *morulum*

62b. Depression not heavily sclerotized 63

63a. Dorsum of abdomen with two rows of black bands, which are broken by white lines (fig. 328). Area between depression of epigynum of genital groove swollen (fig. 327); Alaska, western Canada .. *impressum*

63b. Dorsum of abdomen with different markings; depression of epigynum touching genital groove 64

64a. Depression indistinctly visible 66

64b. Depression distinct 65

65a. Openings of ducts on anterior margin of depression (figs. 351, 352) ... *aurantium*

65b. Openings of ducts on lateral margins of depression (figs. 344-348) ... *sexpunctatum*

66a. Epigynum with a white raised area, almost twice as wide as long, with indications of CD in center of area (fig. 160); SR spindle-shaped (fig. 159); western states ..... *michelbacheri*

66b. Epigynum otherwise, with one or two indistinct openings 67

67a. Epigynum with two openings though they may be difficult to see .. 69

67b. Epigynum not with two openings 68

68a. Epigynum with area close to genital groove shaded; SR oval, their length from margin (figs. 112, 113); southwestern states ... *dilutum*

68b. Epigynum with an indistinct slit; SR spherical, more than their diameter from margin (figs. 110-111); southeastern states .. *intritum*

69a. Internal genitalia a coil of CD (figs. 145, 149, 150) 70

69b. Ducts short; or if long, with one or two loops 71

70a. Head portion of carapace black; southeastern states ..... *australe*

70b. Head portion of carapace not black; western states .. *goodnightorum*

71a. Anterior to each opening a short piece of duct visible running parallel to margin (fig. 141); Texas ..... *hidalgo*

71b. CD, if visible, not running parallel to margin 72

72a. CD forming a large loop, small dumbbell-shaped SR close to margin (fig. 126); Texas ..... *cynicum*

72b. CD without large loop, sometimes thickened (figs. 142, 143); abdomen often with a pair of black spots on white venter; southern California .. *geminipunctum*

73a. Epigynum with openings on a raised plate with median marks 74

73b. Epigynum otherwise 75

74a. Raised plate with a median dark mark (fig. 258); western states ... *lawrencei*
74b. Raised plate with two median marks (fig. 256); northern and Rocky Mountain states ... *montanum*
75a. Epigynum a raised area having two dark anterior lobes (fig. 250); Pacific Coast ... *saanichum*
75b. Epigynum with a posterior projecting lobe, having a V-shaped mark (fig. 108); southeastern states ... *flavonotatum*

Key to male *Theridion* of Canada and the United States

(Abbreviations used: C, conductor; E, embolus; M, median apophysis; R, radix; T, tegulum). Figures with capitalized initial letters refer to the present paper; those with lower case (figs.) to Levi 1957, unless otherwise stated.

1a. M bifid (with two prongs in mesal view) ... 5
1b. M not bifid (in mesal view) ... 2
2a. E on mesal side, completely visible in ventral view ... 22
2b. E on ventral or ectal side or hidden ... 3
3a. E partly hidden by T or C ... 27
3b. E completely visible in ventral view ... 4
4a. E with broad subcircular base and filiform portion longer than diameter of base (figs. 58, 60, 121, 154) ... 42
4b. E otherwise ... 67
5a. Proximal prong of M more than twice length of other ... 27
5b. Prongs of equal length or distal prong longer ... 6
6a. Prongs separated by a distance greater than length of longest prong ... 7
6b. Prongs separated by much less than length of longest ... 13
7a. E with broad subcircular base and filiform distal portion ... 8
7b. E otherwise ... 9
8a. Prongs of M directed towards ventral side (fig. 97); Florida ... *myersi*
8b. Prongs of M directed towards distal end of palpus (fig. 81); widespread ... *rabuni*
9a. E partly hidden by T or C ... 10
9b. E completely visible in ventral view (fig. 338); Alaska to northern United States ... *aurantium*
10a. Proximal prong of M more ventral than distal (figs. 335, 336); southeastern states ... *cheimatos*
10b. Both prongs mesal ... 11
11a. E with a spine on venter (fig. 301); Ontario, eastern states ... *albidum*
11b. E without spine ... 12
12a. Proximal M prong with one tip; C long (figs. 259, 260); Pacific Coast states, Idaho ... *lawrencei*
12b. Proximal prong with two tips in western specimens (fig. 253), one in eastern (fig. 252); C short (fig. 254); northern states, south in Appalachian and Rocky Mts. ... *montanum*

13a. Chelicerae as long as carapace (fig. 261); palpal tibia as long as cymbium (fig. 263); Pacific Coast states ..... *punctipes*
13b. Chelicerae shorter than carapace; palpal tibia shorter than cymbium 14
14a. Proximal more than twice width of distal prong of M 15
14b. Both prongs of equal width or distal prong wider 16
15a. E with broad basal portion and filiform distal on ventral side of T (fig. 88); Texas ..... *cinctipes*
15b. E otherwise and partly hidden by T (fig. 295); southeastern states ..... *pictipes*
16a. M prongs extending beyond T (figs. 296, 297); (Figs. 123, 124); Arizona 17
16b. M prongs not extending beyond bulb (figs. 298, 300) 18
17a. E curved; C with a middle bulge (Fig. 124) ..... *cochise*
17b. E straight; C without bulge in middle (fig. 297) ..... *morulum*
18a. E on ventral, ectal side (fig. 236); Gulf States ..... *istokpoga*
18b. E otherwise if on ectal side partly hidden by T 19
19a. E with a mesal lobe, V-shaped (fig. 293); British Columbia, western states ..... *neomexicanum*
19b. E without mesal lobe 20
20a. E with a ventral spine (fig. 301); Ontario, eastern states ..... *albidum*
20b. E otherwise 21
21a. Distal M prong twice as wide as proximal (fig. 290); British Columbia; western states ..... *leechi*
21b. Both prongs of equal width (fig. 298); widespread ..... *frondeum*
22a. E with a membrane connecting base and distal end (fig. 201); Washington, Oregon ..... *tinctum*
22b. E without membrane 23
23a. Subtegulum filling more than proximal half of cymbium (fig. 185); western states ..... *melanurum*
23b. Subtegulum filling less than proximal one-third of cymbium 24
24a. E with tooth on base; C with projecting tooth (fig. 188); cosmotropical ..... *rufipes*
24b. E and C without tooth 25
25a. Filiform portion of E arising from distal margin of base (fig. 187); British Columbia, Washington ..... *simile*
25b. Filiform portion of E arising from proximal basal margin 26
26a. Width of filiform portion half that of basal portion (fig. 128); Texas ..... *cynicum*
26b. Width of filiform portion less than one-third width of basal portion (fig. 117); southwestern states ..... *submissum*
27a. Cymbium wrapped around bulb (figs. 161, 162); western states ..... *michelbacheri*
27b. Cymbium not so modified 28
28a. C longer than width of cymbium (fig. 321); Alaska to Alberta ..... *impressum*
28b. C shorter than widest width of cymbium 29

29a. M not visible as a distinct projecting sclerite 30
29b. M visible in ventral view as a distinct sclerite 33
30a. E with membrane connecting base with distal portion (fig. 198); cosmotropical ..... *adamsoni*
30b. E without membrane 31
31a. T duct with loops (fig. 322); eastern provinces, eastern states ..... *lyricum*
31b. T duct not visible or without loops 32
32a. E completely hidden in ventral view (fig. 325); Alaska to northern states, Sierras and Rocky Mts. ..... *ohlerti*
32b. E partially hidden by transparent C 71
33a. M a narrow prong parallel to cymbial margin; E prominent, looping across venter of palpus (figs. 195, 197, 203) 34
33b. M otherwise; E inconspicuous, small, not looping across venter 35
34a. Base and distal portion of E connected by a membrane 74
34b. E without such membrane (fig. 203); widespread ..... *alabamense*
35a. M in distal half of palpus 36
35b. M in proximal half of palpus 39
36a. C a sclerotized structure (fig. 241); Pacific Coast ..... *saanichum*
36b. C not sclerotized 37
37a. E with a wide notch; C small (fig. 303); Pacific Coast ..... *agrifoliae*
37b. E otherwise, C larger 38
38a. C wide (fig. 336); southeastern states ..... *cheimatos*
38b. C narrow (figs. 341, 342); Alaska, northern states, Appalachian Mts.; western states ..... *sexpunctatum*
39a. M broad with a prong pointing distally (fig. 304); Pacific Coast ..... *californicum*
39b. M otherwise with a prong pointing ventrally; eastern states 40
40a. E with a mesal tooth (fig. 312) ..... *neshamini*
40b. E without mesal tooth 41
41a. Tegulum duct with two loops visible (fig. 310) ..... *orlando*
41b. Tegulum duct with one loop visible (fig. 308) ..... *pennsylvanicum*
42a. Abdomen black with light spots, a white mark above spinnerets; palpus as in figures 202, 203; widespread ..... *alabamense*
42b. Abdomen palpus otherwise 43
43a. Filiform portion of E longer than twice cymbial length 44
43b. Filiform portion of E shorter than one and one-half cymbial length 45
44a. Filiform portion originating from proximal margin of its base (fig. 152); eastern provinces and states ..... *glaucescens*
44b. Filiform portion originating from mesal margin of its base (fig. 154); southwestern states ..... *transgressum*
45a. T rugose on ectal margin 46
45b. T smooth 47
46a. T with a projection having both sides rugose (fig. 101); widespread ..... *differens*
46b. T with only ectal side rugose (fig. 103); southeastern states ..... *flavonotatum*

47a. T bulging ectally (fig. 128); in ventral view width of T greater than outline of E; Texas ..... *cynicum*
47b. T otherwise 48
48a. Visible portion of M appearing as the edge of a disk in mesal view (figs. 116, 120, 124) 49
48b. Visible portion of M otherwise 51
49a. Width of E base equal to width of T visible in ventral view (fig. 117); southwestern states ..... *submissum*
49b. T hardly visible on ectal side in ventral view 50
50a. E loop less than half cymbium length (fig. 125); southwestern states .. *dilutum*
50b. E loop more than two-thirds cymbial length (fig. 121); southeastern states ..... *intritum*
51a. M in mesal view higher than wide with a distally directed small lobe (figs. 129, 131, 133, 135) 52
51b. M otherwise 55
52a. Filiform portion originating from ectal margin of its base 53
52b. Filiform portion originating from proximal margin 54
53a. Cephalic portion of carapace black; widespread ..... *australe*
53b. Coloration otherwise ..... *goodnightorum*
54a. Palpus as in figure 134; Texas ..... *hidalgo*
54b. Palpus as in figure 136; Arizona, California ..... *geminipunctum*
55a. M four lobed (figs. 175, 176); British Columbia, Washington .. *varians*
55b. M otherwise 56
56a. M sickle-shaped (fig. 59); Canada, northern states, Rocky Mts. .... *petraeum*
56b. M otherwise 57
57a. M with a shallow notch (fig. 81; Fig. 42) 58
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Key to Female *Theridion* from Mexico, West Indies, Central and South America

(Abbreviations: SR, seminal receptacles; CD, connecting canals.) Figures capitalized refer to illustrations in this paper; figures in lower case (fig.) refer to the previous papers (1957, 1959), as indicated.

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168a. Posterior margin sclerotized; rim indistinct; CD with two elbows (1959, figs. 187, 188); Mexico ..... *apulco*
168b. Posterior margin not sclerotized; rim distinct; CD with bend (1959, figs. 255, 256); Panama ..... *plantatum*
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169b. Lateral margins not so sclerotized 170

170a. Transverse portions of CD visible anterior to depression (1959, figs. 177, 178); Mexico to Panama ..... *trepidum*
170b. No transverse CD portions visible in epigynum 171
171a. Two subcircular dark marks visible anterior to depression (1959, figs. 227, 228); Mexico to Panama ..... *nudum*
171b. No such dark marks visible 172
172a. CD entering depression from sides (1959, figs. 234, 235); Panama to Ecuador ..... *barroanum*
172b. CD otherwise 173
173a. Depression rims sclerotized, coiled on sides (Figs. 82, 83); Costa Rica ..... *cocosense*
173b. Depression rims not so coiled 174
174a. CD with one large loop (1959, figs. 89, 90); West Indies ..... *submissum*
174b. CD without loop 175
175a. CD visible through epigynum (Fig. 138); Central America, Venezuela ..... *costaricaense*
175b. CD not visible through epigynum (1959, figs. 208, 209); Panama ..... *centrum*
176a. Depression more than its length from margin 177
176b. Depression less than its length from margin 179
177a. CD coiled (1957, figs. 157, 158); Mexico ..... *transgressum*
177b. CD with at most one loop 178
178a. CD wider than SR radius (1959, figs. 313, 314); Panama, Lesser Antilles ..... *artum*
178b. CD width less than one-quarter SR diameter (1959, figs. 87, 88); Mexico to Panama ..... *elisabethae*
179a. A posterior median sclerotized spot behind depression (1959, figs. 242, 243); Mexico ..... *pallisterorum*
179b. No such spot present 180
180a. A sclerotized spot anterior to depression (1959, figs. 303, 304); Mexico ..... *atlixco*
180b. Without such spot 181
181a. CD with loops or coils 182
181b. CD short without loops or coils 183
182a. CD with coil (Figs. 184, 185); southeastern Brazil ..... *rubrum*
182b. CD with a loop (Figs. 242, 243); Peru ..... *isorium*
183a. Depression about three times as wide as long (1949, figs. 240, 241); Trinidad ..... *nadleri*
183b. Depression subcircular or not more than twice as wide as long 184
184a. CD entering a sac anterior of depression, sac with thin dorsal wall (Figs. 149, 150); Peru ..... *parvum*
184b. CD otherwise 185
185a. CD leading into wide lateral sacs of depression (1959, figs. 236, 237); Central America, West Indies, Ecuador ..... *scxmaculatum*
185b. CD of equal width 186
186a. CD as long as SR diameter (1959, figs. 263, 264); Panama to Ecuador ..... *panamense*

186b. CD as long as SR radius 187
187a. Abdomen generally wider than long; Mexico to southern Brazil ..... *atropunctatum*
187b. Abdomen longer than wide; Peru ..... *monzonense*
188a. Epigynum with a median sclerotized cone (Figs. 32, 33); Brazil ..... *pernambucum*
188b. Epigynum otherwise 189
189a. Epigynum with two ducts opening into margin (Figs. 186, 187); Peru ..... *schlingeri*
189b. Epigynum otherwise 190
190a. Epigynum with shadows of two longitudinal parallel ducts (Figs. 258, 259); Brazil ..... *opolon*
190b. Epigynum otherwise 191
191a. Epigynum showing V-shaped ducts (Figs. 218, 222) 192
191b. Epigynum otherwise 195
192a. Epigynum margin rounded (1957, fig. 108); West Indies ..... *flavonotatum*
192b. Epigynum margin straight 193
193a. V-shaped duct looping on itself (Figs. 217, 218); Brazil ..... *impigrum*
193b. V-shaped duct with slight loop only 194
194a. V-shaped duct of equal width (Figs. 221-224); Brazil ..... *nigriceps*
194b. V-shaped duct narrower near opening (1959, figs. 318, 319); Panama ..... *reservum*
195a. CD with symmetrical coils (1959, figs. 223, 224); West Indies ..... *antillanum*
195b. CD without symmetrical coils 196
196a. Epigynum with a slight posterior lip, duct opening anterior to SR (1959, figs. 295, 296); Mexico ..... *malkini*
196b. Epigynum without lip; duct opening posterior to SR 197
197a. CD straight without bends, loops or coils (Fig. 239); Ecuador, Peru ..... *exlinae*
197b. CD with loops or coils 198
198a. CD coiled 199
198b. CD with a single loop 201
199a. Cephalic portion of carapace black (1957, figs. 148-151); West Indies ..... *australe*
199b. Coloration otherwise 200
200a. Mexico (1957, figs. 145-147) ..... *goodnightorum*
200b. Paraguay (Figs. 180, 181) ..... *maron*
201a. CD loop beyond anterior edge of SR (1957, figs. 142-144); Baja California ..... *geminipunctum*
201b. CD loop posterior to SR 202
202a. Epigynum with two indistinct openings (1957, figs. 139-141); Mexico ..... *hidalgo*
202b. Epigynum with a shadow near margin (1957, figs. 112-113, 123); Mexico ..... *dilutum*

Key to Male *Theridion* of Mexico, West Indies, Central and South America

(Abbreviations used: C, conductor; E, embolus; M, median apophysis; R, radix; T, tegulum). Figures capitalized refer to illustrations in this paper.

1a. Palpus with many long transparent lobes; except for filiform portion of E no sclerotized portions present (1959, fig. 226; Fig. 213) 2
1b. Palpus otherwise 3
2a. Palpus as in 1959, figure 226; West Indies .... *antillanum*
2b. Palpus as in Figure 213; southern Brazil .... *biezankoi*
3a. E in ventral side with a subcircular basal portion and a free long filamentous portion; filament directed clockwise in the left palpus (*T. murarium* group) 20
3b. E otherwise 4
4a. E on ventral or distal side of palpus, with E directed counterclockwise in left palpus 13
4b. E otherwise 5
5a. E filament clockwise, but filament not free, tied to base by membranes 8
5b. E otherwise 6
6a. M heavily sclerotized, usually with two, sometimes one to three prongs in mesal view (Figs. 59, 135) (*T. frondeum* group) 56
6b. M lightly sclerotized or hidden, never with one to three prongs 7
7a. E apparently in distal, mesal quarter of palpus 91
7b. Palpus otherwise 110
8a. E with a distal coil (1957, fig. 198); cosmotropical .... *adamsoni*
8b. E otherwise 9
9a. Distal, filiform portion of E free (Fig. 179); Ecuador, Peru .... *fungosum*
9b. E otherwise 10
10a. E on mesal side of palpus only (1959, fig. 249; Fig. 174); Panama to Peru .... *minutissimum*
10b. E covering venter of palpus 11
11a. Distal end of E elbowed (1959, fig. 244); Mexico .... *pallisterorum*
11b. Distal end of E otherwise 12
12a. Distal tip of E supported by C (1959, fig. 239); West Indies, Central America to Amazon .... *sexmaculatum*
12b. Distal tip of E free (1959, fig. 248); West Indies, Mexico to Panama .... *dotanum*
13a. Base of E a plate with filiform part originating from distal margin (Figs. 36, 37); Colombia, Ecuador .... *iramon*
13b. E otherwise 14
14a. T with duct looping (1959, fig. 252); Panama .... *akron*
14b. T otherwise 15
15a. E almost without broad base, gently tapering (1959, fig. 171); Mexico, Guatemala .... *styligerum*

15b. E otherwise 16
16a. Filiform part originating from proximal portion of E base (1957, fig. 238, Fig. 178); United States to southern Brazil ..... *positivum*
16b. Filiform part originating on ectal or ventral side of E base 17
17a. Filiform part originating on ventral side of E base; C broad (1959, fig. 218); Bahama Isl. ..... *cazieri*
17b. Filiform part originating on ectal side of E 18
18a. E elbowed (1957, fig. 236); Mexico ..... *istokpoga*
18b. E curved 19
19a. E base with a proximal lobe (1959, fig. 215); Panama ..... *albulum*
19b. E base rounded (1959, fig. 212); Mexico ..... *sinaloa*
20a. Filiform portion of E reversing direction with a U-loop (Fig. 10); Venezuela to Ecuador ..... *volubile*
20b. E otherwise 21
21a. R rugose (Fig. 210); Lesser Antilles ..... *nesticum*
21b. R never rugose 22
22a. Base of E deeply notched (Fig. 5) ..... *soaresi*
22b. Base of E without such notch 23
23a. Width of loop of filiform part of E equal to width of palpus 24
23b. Width of loop less than palpal width 30
24a. E loop longer than wide (Figs. 3, 4); Brazil ..... *bolum*
24b. E loop as long as wide or wider than long 25
25a. Filiform part originating from mesal margin of E base (1957, fig. 154); Mexico ..... *transgressum*
25b. Filiform part originating from distal or ectal border 26
26a. Filiform part originating from distal border of E base (1959, figs. 101, 102); Mexico; West Indies to Brazil ..... *hispidum*
26b. Filiform part originating from ectal margin of E base (Figs. 21, 24) 27
27a. E base with a distal hump (Fig. 21); Ecuador, Peru ..... *fastosum*
27b. E base otherwise 28
28a. Palpus wider than long (Fig. 24); southern Brazil ..... *tinctorium*
28b. Palpus as wide as long or longer than wide (1957, figs. 130, 132) 29
29a. Cephalic portion of carapace black; Mexico, West Indies ..... *australe*
29b. Coloration otherwise; Mexico ..... *goodnightorum*
30a. Abdomen with transverse black stripes (Fig. 9); southeastern Brazil ..... *striatum*
30b. Abdomen otherwise 31
31a. Filament shorter than longest diameter of E base 32
31b. Filament longer than longest diameter of E base 33
32a. M small; palpus as in Figure 44; Chile, Paraguay ..... *foliaceum*
32b. M large, palpus as in Figure 47; Peru ..... *utcuyacu*
33a. T swollen, E on mesal side of palpus 34
33b. T otherwise 36
34a. Width of filament greater than space between it and E base (1957, fig. 128); Mexico ..... *cynicum*
34b. Width of E filament less than space between it and base 35

35a. Diameter of E loop about half length of palpus (1957, fig. 117); Mexico, West Indies ..... *submissum*
35b. Longest diameter of E loop about two-thirds length of palpus (Fig. 25); Mexico ..... *opuntia*
36a. M prominent 40
36b. M lightly sclerotized 37
37a. Palpus as in Figure 54; Chile ..... *ambiguum*
37b. Palpus otherwise 38
38a. T with a mesal projection (1959, fig. 321); Panama ..... *reservum*
38b. T without projection 39
39a. Palpus as in 1959, figure 229; Mexico to Panama ..... *nudum*
39b. Palpus as in Figure 236; Brazil ..... *olaup*
40a. Filiform part originating on mesal side of E base 41
40b. Filiform part originating otherwise 42
41a. Filament short (Fig. 236); Brazil ..... *olaup*
41b. Filament long (Figs. 1, 2); Brazil ..... *filum*
42a. E base with distal lobe (Fig. 47); Peru ..... *utcuyacu*
42b. E base otherwise 43
43a. Filiform part originating on distal margin of E base (Figs. 36, 37); Colombia, Ecuador ..... *iramon*
43b. E otherwise 44
44a. M disk-shaped (1957, fig. 124); Mexico ..... *dilutum*
44b. M otherwise 45
45a. T rugose on ectal side (1957, fig. 103); West Indies ..... *flavonotatum*
45b. T smooth 46
46a. M with a distally projecting tooth (1957, figs. 57, 133, 135) 47
46b. M otherwise 49
47a. C large, sclerotized (1957, fig. 58); Mexico ..... *murarium*
47b. C small, weakly sclerotized 48
48a. Filiform portion originating on ectal side of E base (1957, fig. 136); Baja California ..... *geminipunctum*
48b. Filiform portion originating on proximal side of E base (1957, fig. 134); Tamaulipas, Mexico ..... *hidalgo*
49a. M with two subequal prongs (Figs. 30, 31); eastern Brazil ..... *pernambucum*
49b. M otherwise 50
50a. M two-pronged, with proximal prong longer 51
50b. M otherwise 52
51a. M with an anterior broad lobe (1957, fig. 87); Mexico ..... *cinctipes*
51b. M without anterior lobe (Figs. 40, 41); Venezuela ..... *stamotum*
52a. Distal edge of E base almost straight and transverse to long axis of palpus 53
52b. E base otherwise 55
53a. C projecting on mesal side (1959, fig. 81); West Indies, Central America, Venezuela ..... *dilucidum*
53b. C otherwise 54

54a. E filament touching base of palpus (1959, fig. 104); Panama ... *valleculum*
54b. E filament short (1957, fig. 98); Mexico, West Indies ... *myersi*
55a. M with bulges facing distally (1957, figs. 81, 82); Bahama Isl. ... *rabuni*
55b. M with a proximally directed prong (1959, figs. 85, 86); Panama ... *galerum*
56a. Palpus as in Figure 229; Venezuela ... *osprum*
56b. Palpus otherwise ... 57
57a. Subtegulum notched (1959, figs. 129, 131, 133, 135; Figs. 59, 60) ... 58
57b. Subtegulum without notch ... 59
58a. Abdomen with black spots (Fig. 63); E with a mesal distal lobe, U-shaped (Figs. 59, 60); Peru ... *nigroannulatum*
58b. Abdomen black, venter with a median white spot; E without mesal distal lobe (1959, figs. 128-135); Mexico, West Indies to Brazil ... *erexum*
59a. Palpal tibia longer than palpus (1957, fig. 263); Baja California ... *punctipes*
59b. Palpal tibia shorter than palpus; or if as long, found in South America or West Indies ... 60
60a. T a heavily sclerotized ectal shield (Fig. 75); Peru ... *grandiosum*
60b. T otherwise ... 61
61a. M with three prongs (1959, fig. 136); Central America ... *tristani*
61b. M otherwise ... 62
62a. M with one prong, portion visible in ventral view longer than wide (Fig. 136) ... 63
62b. M with two prongs, or portion visible in ventral view wider (higher) than long (Figs. 109, 119, 125) ... 68
63a. Prong sickle-shaped; two parallel ducts visible in T (1959, figs. 165-167); Mexico ... *niveum*
63b. Prong otherwise ... 64
64a. Prong with a ventral distal notch (1959, figs. 181, 182); Mexico ... *martini*
64b. Prong otherwise ... 65
65a. Prong with large projection on distal surface (Figs. 135, 136); Mexico ... *schrammeli*
65b. Prong otherwise ... 66
66a. Only tip of prong visible beyond cymbium margin (1959, figs. 203, 204); Mexico ... *uncatum*
66b. Prong otherwise ... 67
67a. Prong in ventral view slightly S-shaped, T with a distal notch (Fig. 108); Peru ... *huanuco*
67b. Prong in ventral view straight, T without notch (1959, figs. 155-158); Panama ... *metabolum*
68a. M with two prongs ... 75
68b. M with one prong higher (wider) than long ... 69

69a. M disk-shaped with proximal notch (1959, figs. 179, 180); Mexico, Panama ..... *trepidum*
69b. M otherwise 70
70a. M with distally directed spine (Fig. 110) 72
70b. M without prongs or spines (1959, figs. 146, 150); Mexico 71
71a. Mesal margin of T bulging (1959, fig. 147) ..... *contreras*
71b. Mesal margin of T with a shallow notch (1959, fig. 151) ..... *leones*
72a. M with a tooth in middle of ventral margin (1959, fig. 140); Puerto Rico ..... *ricense*
72b. M without tooth in middle of ventral margin 73
73a. T ducts nearly parallel; M with small prong on proximal margin (1959, figs. 175, 176, 201, 202) 74
73b. T ducts not parallel; M with lobe on proximal margin (Figs. 109, 110); Venezuela to Ecuador ..... *frizzellorum*
74a. E with a mesal, distal lobe (1959, fig. 202); Mexico ..... *dreisbachi*
74b. E with mesal edge concave (1959, fig. 176); Guatemala ..... *omiltemi*
75a. Proximal prong twice as long as distal (Figs. 135, 136); Mexico ..... *schrammeli*
75b. Prongs subequal in length or distal prong longer 76
76a. Prongs separated by at least twice length of longest one (1959, fig. 142) 77
76b. Prongs separated by less than length of longest one 78
77a. Distal prong truncate (1959, fig. 150); Mexico ..... *leones*
77b. Distal prong curved (1959, fig. 142); Mexico ..... *crucum*
78a. Proximal prong notched on distal surface (Figs. 119, 120); Venezuela ..... *botanicum*
78b. Proximal prong not notched 79
79a. Distal prong narrower than proximal one 80
79b. Distal prong wider or subequal to width of proximal prong 81
80a. Distal prong elbowed (Figs. 125, 126); Venezuela ..... *tebanum*
80b. Distal prong straight (Figs. 131, 132); Mexico to Brazil ..... *unanimum*
81a. Distal prong with a tooth and notch on proximal margin (1959, fig. 118) and T extending distal of M (1959, fig. 119); Mexico ..... *sanctus*
81b. M or T otherwise 82
82a. E U-shaped with both ends of equal width (Figs. 70, 71); Venezuela ..... *aragua*
82b. E otherwise 83
83a. Distal prong elbowed in mesal view; both prongs projecting ventrally (1957, figs. 296, 297); Mexico ..... *morulum*
83b. M otherwise 84
84a. Proximal prong a small lobe on proximal margin of distal prong; distal prong extending more than four times length of proximal prong (Figs. 64, 121); Bolivia 85
84b. M larger and distal lobe extending not more than three times length of proximal prong (1959, fig. 120) 86
85a. T with two parallel ducts; distal margin of distal prong swollen (Figs. 64, 65) ..... *rurrenabaque*

85b. T with ducts not visible; distal prong without swelling (Figs. 121, 122) ..... *chacocnse*
86a. E with a ventral bulge (1959, fig. 110); Mexico ..... *coyoacan*
86b. E without ventral bulge 87
87a. C widest at base; mesal T duct straight (1959, figs. 120, 121); Mexico ..... *barbarae*
87b. C widest at distal end; mesal T duct curved 88
88a. Mesal T duct with a proximal loop, ectal duct with a distal loop (1959, fig. 106); Mexico ..... *rothi*
88b. Ducts otherwise 89
89a. T wider than long with 2 subparallel ducts (Figs. 127, 128); Venezuela ..... *ravum*
89b. T longer than wide, ducts otherwise 90
90a. E with mesal distal projection; proximal M prong touching tibia (1959, figs. 111-112); Mexico to Panama ..... *adjacens*
90b. E concave on mesal distal margin; proximal M prong some distance from palpal tibia (Figs. 100, 101); Venezuela to Argentina .... *calcynatum*
91a. Subtegulum and T heavily sclerotized almost black (Fig. 209); Brazil ..... *aulos*
91b. Subtegulum and T never heavily sclerotized 92
92a. T ducts with several lateral loops, duct as wide as space between loops (1959, fig. 252); Panama ..... *akron*
92b. T otherwise 93
93a. E with ventral tooth, C with transverse spine (1957, figs. 188, 189); cosmotropical ..... *rufipes*
93b. E and C otherwise 94
94a. Cymbium drawn out on mesal, distal margin (1957, figs. 222-224); Mexico to Ecuador ..... *crispulum*
94b. Cymbium rounded distally 95
95a. T duct S-shaped (Fig. 234) 96
95b. T duct otherwise 97
96a. E, C directed mesally (1959, fig. 326); Panama to Venezuela ..... *marvum*
96b. E, C directed almost parallel to cymbium axis; C with ectal bulge (Fig. 234); Venezuela ..... *beebei*
97a. Palpal femur with spine (Figs. 237, 238); Ecuador, Peru ..... *exlinae*
(also probably Argentina ..... *bergi*)
97b. Palpal femur without spine 98
98a. R with a curved extension beyond cymbium (1959, fig. 288); Mexico ..... *moctezuma*
98b. R otherwise 99
99a. Most sclerites hidden; only an oval structure visible on distal end of T (Fig. 235); Mexico ..... *cuyutlan*
99b. Palpus otherwise 100
100a. T with a distal loop in duct (1959, figs. 266, 325) 102
100b. T duct otherwise 101

101a. E very large, base larger than visible portion of T in ventral view (Fig. 244); southern Brazil ..... *plaumanni*
101b. Visible T portion always larger than E base 103
102a. C narrow, extending beyond cymbium (1959, figs. 265, 266); Panama to Ecuador ..... *panamense*
102b. C otherwise (1959, fig. 325); Mexico ..... *ruinum*
103a. E unsupported, hook-shaped (Fig. 206); Venezuela ..... *maranum*
103b. E otherwise 104
104a. Sclerites appearing pincer-like at distal end of palpus (Fig. 231); Mexico ..... *stannardi*
104b. Sclerites otherwise 105
105a. C squarish, stalked (Figs. 225, 233) 106
105b. C of different shape 107
106a. Palpus as in Figure 233; Venezuela to Peru ..... *rampum*
106b. Palpus as in Figure 225; Brazil ..... *opolon*
107a. T tipped by a bulging transparent sclerite (1959, fig. 268); Panama ..... *chiriqui*
107b. T otherwise 108
108a. C a transparent stalk (Figs. 162, 174) 109
108b. C otherwise; palpus as in 1959, figure 284; Panama, Trinidad, Peru ..... *petrum*
109a. Tip of E bent mesally or distally (1959, fig. 249; Fig. 174); Panama to Peru ..... *minutissimum*
109b. Tip of E bent ectally (1957, fig. 225; Figs. 161, 162); Mexico, West Indies to southern Brazil ..... *atropunctatum*
110a. T with an eye-like spot (Figs. 207, 208); Brazil ..... *umbilicus*
110b. T otherwise 111
111a. Cymbium wrapped around bulb (1959, fig. 205); Guatemala ..... *cavipalpe*
111b. Cymbium otherwise 112
112a. C projecting beyond ectal margin of cymbium 113
112b. C otherwise 114
113a. C distally bulging (1959, fig. 332); Panama ..... *signum*
113b. C distally only slightly expanded (1959, fig. 333); Panama, Brazil ..... *signaculum*
114a. T with a mesal spine (probably the C) (1959, fig. 328); Mexico ..... *bridgesi*
114b. T otherwise 115
115a. T duct with a distal loop (1959, figs. 276, 317, 330, 331); Central America 116
115b. T without such loop 119
116a. Cymbium with a mesal spine (1959, fig. 276) ..... *lathropi*
116b. Cymbium without spine 117
117a. E extending beyond C (1959, fig. 331) ..... *schmidti*
117b. C extending beyond E 118
118a. Palpus as in 1959, figure 317 ..... *quantum*
118b. Palpus as in 1959, figure 330 ..... *paidiscum*

119a. Palpus with a sclerite projecting mesally (1959, fig. 324); Jamaica ... *clemens*
119b. Palpus otherwise ... 120
120a. C tip sclerotized and as in 1959, figure 327; Nicaragua ... *musawas*
120b. Palpus otherwise ... 121
121a. C, E, M elbowed (1959, fig. 231); Panama ... *rufipunctum*
121b. Palpus otherwise ... 122
122a. Palpus weakly sclerotized and as in 1959, figure 222; Jamaica ... *jamaicense*
122b. Palpus otherwise; South America ... 123
123a. E in ectal half of palpus (Fig. 230); Brazil ... *urucum*
123b. E in mesal half of palpus ... 124
124a. Palpus as in Figure 226; southern Brazil ... *ribiginosum*
124b. Palpus otherwise ... 125
125a. E bent (Fig. 227); Brazil ... *aporum*
125b. E straight (Fig. 229); Venezuela ... *osprum*

Theridion glaucescens Becker

Theridion glaucescens Becker, 1879, Ann. Soc. Ent. Belgique, 22: 81, pl. 1, fig. 11, ♀. —Levi, 1957, Bull. Amer. Mus. Nat. Hist., 112: 44, figs. 152, 153, 155, 156, ♀, ♂, map 14.

Theridion volatile Keyserling, 1884, Die Spinnen Amerikas, Theridiidae, 1: 60, pl. 3, fig. 35, ♀, ♂. Female syntypes from Caracas, Venezuela, in the Institut Royal des Sciences Naturelles de Belgique, examined. NEW SYNONYMY.

Note. The type locality of *T. volatile* is almost certainly in error since *T. glaucescens* is not known south of the United States. Specimens of *T. volatile* belonging to the Keyserling collection in the British Museum, from Florida, are *T. flavonotatum* Becker.

Theridion dilucidum Simon

Map 3

Theridion dilucidum Simon, 1897, Proc. Zool. Soc. London, p. 862. Female type from St. Vincent Island in the British Museum, examined. —Levi, 1959, Bull. Mus. Comp. Zool., 121: 84, figs. 78-81, ♀, ♂.

Additional records. Lesser Antilles: Baltazar Isl. in piles of rotten weeds. *Venezuela. Dist. Fed.:* Caracas, 1887-1888 (E. Simon, MNHN).

Theridion filum sp. n.

Figures 1-2

Holotype. Male from Nova Teutonia, lat 27°11′S, long 52°23′W, Santa Catarina, Brazil (F. Plaumann), in the Senckenberg Museum (no. RII/8129/1). The specific name meaning

thread, is a noun in apposition.

Description. Carapace, sternum, legs yellow. Abdomen whitish with some gray and white pigment. Venter with a transverse gray line anterior to spinnerets. Anterior median eyes slightly larger than others, lateral eyes smallest. Anterior median eyes one diameter apart, less than one-quarter diameter from laterals. Posterior median eyes two-thirds diameter apart, one diameter from laterals. Total length 1.9 mm. Carapace 0.78 mm long, 0.69 mm. wide. First femur, 1.82 mm; patella and tibia, 1.95 mm; metatarsus, 1.56 mm; tarsus, 0.55 mm. Second patella and tibia, 1.03 mm; third, 0.57 mm; fourth, 0.91 mm.

Diagnosis. The anterior-pointing median apophysis (Figs. 1, 2) separates this species from *T. bolum*.

Theridion bolum sp. n.

Figures 3-4

Holotype. Male from Minas de Serrinha, Diamantina, Minas Gerais, Brazil, Jan. to March 1945 (E. Cohn), in the American Museum of Natural History. The specific name is an arbitrary combination of letters.

Description. Carapace yellowish with gray margin and head region gray. Sternum gray. Abdomen dark gray with faint indications of two wavy lines on dorsum and intermediate area lighter. Two light spots anterior on dorsum, but no distinct marks on venter. Eyes subequal in size. Anterior median eyes one and one-half diameters apart, almost touching laterals. Posterior eyes their diameter apart. Total length 2.0 mm. Carapace 0.80 mm long, 0.75 mm wide. The specimen has all its legs missing.

Diagnosis. The shape of the long embolus and large median apophysis (Fig. 3) separate this species from *T. transgressum* Petrunkevitch.

Theridion soaresi nomen novum

Figure 5

Theridion bertkaui Soares and Camargo, 1948, Bul. Mus. Paraense, E. Goeldi, 10: 367, fig. 21, ♂. Male type from Chavantina, Mato Grosso, Brazil, in the Dept. de Zoologia de Secretaria da Agricultura, São Paulo, examined. Not *Theridion bertkaui* Thorell, 1881; *Theridion bertkaui*, Bösenberg, 1899.

The spider is almost all white except for two small areas on

each side and above spinnerets which have some black pigment. Anterior median eyes slightly larger than others, two-thirds their diameter apart, one-quarter diameter from laterals. Posterior eyes one diameter apart. Abdomen longer than wide or high. Total length 2.2 mm. Carapace 0.9 mm long, 0.7 mm wide. First femur, 1.6 mm; patella and tibia, 1.7 mm. Second patella and tibia, 1.2 mm; third, 0.7 mm; fourth, 1.1 mm.

The only palpus is mounted in balsam that has crystallized. The palpus has cleared and is slightly flattened (Fig. 5).

Theridion striatum Keyserling

Figures 6-9

Theridium striatum Keyserling, 1884, Die Spinnen Amerikas, Theridiidae, 2(1): 95, pl. 5, fig. 62, ♂. Male holotype from Brazil in the Berlin Museum, apparently lost. — Göldi, 1892, Mitt. Osterlande, neue Folge, 5: 213.

Göldi (1892) indicates that this species was collected in Rio de Janeiro. This species has unusual coloration: a series of black lines on each side of the abdomen dorsum (Fig. 9). It is remarkable that the only available collection of this species contained female specimens of a nesticid of almost similar appearance and also having black lines on the sides of the dorsum.

Record. Brazil. São Paulo: Cidade São Paulo, Botanical Gardens, Jan. 1959, ♀, ♂ (A. M. Nadler, AMNH).

Theridion volubile Keyserling

Figures 10-13

Theridium volubile Keyserling, 1884, Die Spinnen Amerikas, Theridiidae, 2(1): 37, pl. 2, fig. 19, ♀. Female lectotype here designated from Amable María, [640 m elev., Junín, prov. Tarma], Peru, in the Polish Academy of Sciences, Warsaw, examined.

This species is of variable coloration, large collections having both white and dark individuals. Some have the venter light, others black with a white spot on each end of the genital groove and a pair of white spots side by side behind the groove.

The subcircular opening of the epigynum (Figs. 12, 13) varies somewhat in shape, but always has the posterior margin dark. The coils of the connecting ducts are diagnostic but are difficult to see in very dark individuals without examining the internal genitalia (Fig. 11). It is possible that the Brazilian *T. subrotundum* is the same species.

Figures 11 and 12 were prepared from a syntype specimen.

Natural History. This species has been found under stones near Lima and Lobitos, Peru.

Records. Venezuela. Dist. Fed.: Caracas, 1887-1888 (E. Simon, MNHN). *Aragua:* Tovar, 1888 (E. Simon, MNHN). *Ecuador. Manabi:* Manta (H. E., D. L. Frizzell). *Tungurahua:* Baños (H. E., D. L. Frizzell); Ambato (H. E., D. L. Frizzell). *Guayas:* Guayaquil (H. E., D. L. Frizzell). *Peru. Piura:* Cerro Negro (H. E., D. L. Frizzell); Sullana (H. E., D. L. Frizzell); Quebrada Tamarinda (H. E., D. L. Frizzell); Quebrada Mogollón (H. E., D. L. Frizzell); Mallares, Río Chira (D. L. Frizzell); 4 km E of Cabo Blanco (R. Walls); Buena Vista (H. E., D. L. Frizzell); Lobitos (R. Walls). *Junín:* Uteuyacu, 1600-2200 m elev. (F. Woytkowski); Colonia del Perené (E. I. Schlinger, E. S. Ross, CAS). *Lima:* Lima (W. Weyrauch; A. M. Nadler, AMNH). *Arequipa:* Capac, Chala, 200 m elev. (W. Weyrauch, AMNH).

Theridion subrotundum Keyserling

Figures 14-16

Theridium subrotundum Keyserling, 1891, Die Spinnen Amerikas, Brasilianische Spinnen, 3: 183, pl. 6, fig. 128, ♀. Female type Fazenda Serra Vermelha, [Est. Rio de Janeiro], Brazil, in the British Museum, examined.

The abdomen of this species is slightly wider than long. It is possible that the name is a synonym of *T. volubile*, but no specimens other than the types have been found, and *T. volubile* is not known from Brazil.

Theridion antron sp. n.

Figures 17-18

Holotype. Female from Teresópolis, 900-1000 m elev., Est. Rio de Janeiro, Brazil, March 1946 (H. Sick), in the American Museum of Natural History. The specific name is an arbitrary combination of letters.

Description. Carapace yellowish with a median gray line, as wide as eye region in front, narrowing behind. Sternum grayish yellow. Legs yellow with indistinct narrow bands on distal segments. Dorsum of abdomen with two white lines encircling a darker area anteriorly. Sides whitish with some dark pigment. Venter dark with several dark streaks going up sides and a

median white spot between spinnerets and epigynum. A specimen from Pernambuco had the sternum black, abdomen with dorsum white, and venter with a black spot anterior to spinnerets. Eyes subequal in size. Anterior median eyes one diameter apart, one-quarter diameter from laterals. Posterior median eyes one diameter apart, three-quarters diameter from laterals. Total length 2.4 mm. Carapace 0.93 mm long, 0.80 mm wide. First femur, 1.82 mm; patella and tibia, 1.87 mm; metatarsus, 1.40 mm; tarsus, 0.52 mm. Second patella and tibia, 1.05 mm; third, 0.67 mm; fourth, 0.98 mm.

Diagnosis. The epigynum of this species (Fig. 18) is an indistinct structure, the opening is anterior and difficult to see. The seminal receptacles are sclerotized (Fig. 17), but the ducts translucent. Since only few specimens were available for examination, the course of the ducts is somewhat uncertain. It differs from *T. cohni* by having the seminal receptacles posterior to the opening and having the opening lightly sclerotized.

Record. Brazil. Pernambuco: ♀ (SMF). *Santa Catarina:* Nova Teutonia, lat 27°11′S, long 52°23′W, 2 ♀ (F. Plaumann, SMF).

Theridion cohni sp. n.

Figures 19-20

Holotype. Female from Minas Serrinha, Diamantina, Minas Gerais, Brazil, Dec. 1944 (E. Cohn), in the American Museum of Natural History. The species has been named after the collector.

Description. Carapace dusky yellow, darker on sides and head region. Sternum black. Legs yellow-white with narrow black rings. Abdomen whitish with a median white band with regular wavy margins, and a dark outline. Venter black with a white spot on each side of epigastric area and one white spot behind epigynum. Eyes subequal in size. Anterior median eyes three-quarters diameter apart, almost touching laterals. Posterior median eyes their radius apart, a little more than their radius from laterals. Total length 3.3 mm. Carapace 0.98 mm long, 0.91 mm wide. Second patella and tibia, 1.45 mm; third, 0.91 mm; fourth, 1.56 mm.

Diagnosis. The coloration suggests that this species belongs to the *T. murarium* group. The symmetrical coils of the connecting ducts (Fig. 19) separate it from *T. transgressum* Petrunkevitch which also has the opening far forward (Fig. 20). The anterior seminal receptacles separate it from *T. antron.*

Theridion fastosum Keyserling

Figures 21-23

Theridium fastosum Keyserling, 1884, Die Spinnen Amerikas, Theridiidae, 2(1): 58, pl. 3, fig. 34, ♀, ♂. Male lectotype here designated from Pacasmayo, [Libertad], Peru, in the Polish Academy of Sciences, Warsaw, examined.

This small species has an epigynum (Fig. 23) resembling that of *T. serpunctatum* Emerton, but the palpus (Fig. 21) indicates that it belongs to the *T. murarium* group. It is close to *T. hispidum* O. P.-Cambridge. However, small consistent differences in the female ducts (Fig. 22) and the position of the basal portion of the embolus separate it.

Figure 21 was prepared from the male lectotype.

Distribution. Southwestern Ecuador and northwestern Peru.

Records. Ecuador. Los Ríos: Macuchi (H. E., D. L. Frizzell). *Guayas:* Puna Isl. (H. E., D. L. Frizzell); Milagro (H. E., D. L. Frizzell); Guayaquil (H. E., D. L. Frizzell; A. M. Nadler, AMNH). *Peru. Piura:* Miramar (H. E., D. L. Frizzell); Mallares, Río Chira (H. E., D. L. Frizzell); Sullana (H. E., D. L. Frizzell); Pirañas Valley (H. E., D. L. Frizzell). *Libertad:* Pacasmayo, ♀ paratypes (BMNH, PAS).

Theridion hispidum O. P.-Cambridge

Figures 194-195; Map 2

Theridion hispidum O. P.-Cambridge, 1898, Biologia Centrali-Americana, Araneidea, 1: 253, pl. 35, fig. 5, ♂. Male type from Teapa, [Tabasco], Mexico, in the British Museum. —Levi, 1959, Bull. Mus. Comp. Zool., 121: 86, figs. 95-102, ♀, ♂, map 3.

Description. Female from Rio de Janeiro. Carapace, sternum, legs yellow. Abdomen whitish with a median dorsal white band with a wavy outline and slightly darker on sides, darkest above spinnerets. Eyes subequal in size. Anterior median eyes one diameter apart, almost touching laterals. Posterior eyes two-thirds diameter apart. Total length 2.0 mm. Carapace 0.88 mm long, 0.78 mm wide. First femur, 1.70 mm; patella and tibia, 1.71 mm; metatarsus, 1.32 mm; tarsus, 0.53 mm. Second patella and tibia, 1.05 mm; third, 0.66 mm; fourth, 0.99 mm.

Figures 194-195 were made from Buenos Aires specimen.

Note. It is very likely that *T. tinctorium,* known from only the male type from Rio Grande do Sul, belongs to this species. However, it differs in the place of attachment of the filiform portion of the embolus.

Distribution. Mexico, Central America, West Indies, Venezuela, Ecuador, Brazil (Map 2).

Additional records. Mexico. Sonora: El Coyote, 1000 m, web in *Opuntia* cactus, 19 July 1960 (J. A. Beatty). *Yucatan:* Uxmal (C., P. Vaurie, AMNH). *Haiti:* Furcy (A. M. Nadler, AMNH). *Puerto Rico:* Rubianes, Caimital Bajo Ag. (A. F. Archer, AMNH). *Venezuela. Dist. Fed.:* Caracas, 1887-1888 (E. Simon, MNHN); La Guaira, 1887-1888 (E. Simon, MNHN). *Carabobo:* San Esteban, 1888 (E. Simon, MNHN). *Ecuador. Guayas:* Milagro, July 1943 (H. E., D. L. Frizzell). *Brazil. Pará:* Belém, Feb. 1959, ♂ (A. M. Nadler). *Guanabara:* Sumaré, 200-300 m, Rio de Janeiro (H. Sick, AMNH). *Paraguay.* ♀.

Theridion tinctorium Keyserling
Figure 24

Theridium tinctorium Keyserling, 1891, Die Spinnen Amerikas, Brasilianische Spinnen, 3: 185, pl. 6, fig. 130, ♂. Male holotype from Rio Grande do Sul, Brazil, in the British Museum, examined.

Figure 24 was prepared from the holotype. This specimen may belong to *T. hispidum* O. P.-Cambridge, but there are some differences in the structure of the embolus.

Theridion opuntia sp. n.
Figures 25-29

Holotype. Male from El Coyote, 970 m elev., Sonora, Mexico, in webs of *Opuntia*, 9 July 1960 (J. A. Beatty) in the Museum of Comparative Zoology. The specific name is a noun in apposition after the cactus genus.

Description. Carapace yellowish. Eye region grayish with a gray line going from lateral eyes to center of carapace and a black, median, longitudinal line posterior. Sternum yellow. Legs yellow. Abdomen with two long fine jagged white lines, black between and outside of lines. Sides whitish, venter whitish without pigment. Female darker than male, legs with dark spots more distinct below. Female has black semicircular marks on each side of pedicel. Anterior median eyes slightly larger than others, their diameter apart, one-quarter diameter from laterals. Posterior median eyes two-thirds diameter apart, one diameter from laterals. Total length of female 3.0 mm. Carapace 1.1 mm long, 0.9 mm wide. First femur, 2.00 mm; patella and tibia, 2.20 mm; metatarsus, 0.80 mm; tarsus, 0.24 mm. Second patella

and tibia, 1.20 mm; third, 0.84 mm; fourth, 1.4 mm. Total length of male 2.3 mm. Carapace 0.92 mm long, 0.88 mm wide. First femur, 1.95 mm; patella and tibia, 2.00 mm; metatarsus, 1.75 mm; tarsus, 0.60 mm. Second patella and tibia, 1.10 mm; third, 0.80 mm; fourth, 1.20 mm.

Diagnosis. The embolus (Fig. 25) is larger than that of *Theridion submissum* Gertsch and Davis. The tegulum is more spherical than that of *T. dilutum* Levi. The female ducts (Figs. 26, 29) widen before reaching the seminal receptacles, and loop anterior to them. The position seems to be quite variable. The epigynum (Figs. 27, 29) is quite an indistinct structure.

Records. 2 ♀ paratypes collected with ♂ holotype.

Theridion pernambucum sp. n.

Figures 30-33

Holotype. Female from Recife, Pernambuco, Brazil, in the Senckenberg Museum (no. RII/13439/1). The species is named after the state of Pernambuco.

Description. Carapace, sternum dark gray-brown. Legs yellow with coxae, patellae black and narrow black bands around distal ends of segments, except tarsi darker yellow. Dorsum of abdomen whitish with a longitudinal white band having wavy margins on a darker background. Venter of abdomen black, usually with a white spot on each side near epigynum and a pair of white spots behind epigynum; short, black extensions anterior to and on each side of spinnerets. However, markings on venter quite variable. The male is lighter than the female and the carapace and sternum are yellowish. Eyes subequal in size. Anterior median eyes one diameter apart, less than half their radius from laterals. Posterior eyes two-thirds their diameter apart. Chelicerae without teeth. Total length of female 1.5 mm. Carapace 0.59 mm long, 0.59 mm wide. First femur, 0.85 mm; patella and tibia, 0.86 mm; metatarsus, 0.62 mm; tarsus, 0.39 mm. Second patella and tibia, 0.62 mm; third, 0.47 mm; fourth, 0.69 mm. Total length of male 1.4 mm. Carapace 0.68 mm long, 0.64 mm wide. First femur, 1.06 mm; patella and tibia, 1.20 mm; metatarsus, 0.96 mm; tarsus, 0.35 mm. Second patella and tibia, 0.75 mm; third, 0.55 mm; fourth, 0.78 mm.

Diagnosis. The epigynum has a unique median, sclerotized partition; the openings are on each side, and each has a posterior lip (Fig. 33). The median apophysis of the palpus has two huge

lobes (Fig. 30). These characters separate this species from others of the *T. murarium* group.

Records. ♀, ♂ paratypes from Pernambuco, Brazil, and ♀ paratype collected with holotype.

Theridion choroni sp. n.

Figures 34-35

Holotype. Female from Choroní, Rancho Grande, Aragua, Venezuela, 9 March 1959 (A. M. Nadler), in the American Museum of Natural History. The specific name is a noun in apposition after the type locality.

Description. Carapace yellowish-white with a median longitudinal, dusky band, as wide as eye region in front, narrower behind. Sternum yellow-white. Legs yellow-white with indistinct darker bands. Abdomen with a median dorsal, longitudinal white band; some white marks on sides and some black area. Venter of abdomen whitish. Eyes subequal in size. Anterior median eyes one diameter apart, their radius from laterals. Posterior median eyes a little less than their diameter apart, one diameter from laterals. Total length 1.7 mm. Carapace 0.88 mm long, 0.70 mm wide. First femur, 1.28 mm; patella and tibia, 1.32 mm; metatarsus, 1.04 mm; tarsus, 0.52 mm. Second patella and tibia, 0.91 mm; third, 0.65 mm; fourth 1.03 mm.

Diagnosis. The epigynum of the female has two circular openings, their diameter apart (Fig. 35). Anterior to the openings and behind are indications of shadows of the long dark connecting ducts. The seminal receptacles (Fig. 34) are oval and thin-walled. *T. choroni* is not similar to any other *Theridion*.

Theridion iramon sp. n.

Figures 36-39

Holotype. Male from Baños, Tungurahua Prov., Ecuador, 7 May 1942 (H. E. Frizzell), in the Museum of Comparative Zoology. The specific name is an arbitrary combination of letters.

Description. Carapace, sternum grayish yellow-brown. Legs yellow-brown. Abdomen black, with dorsum having two parallel white lines with branches down sides; lines are fused in front and behind where they continue as a single median line to spinnerets. Female is darker than male and has abdomen black with only light area posterior to genital furrow. Anterior median

eyes slightly larger than others, two-thirds diameter apart, one-third diameter from laterals. Posterior median eyes a little more than one diameter apart, one and one-quarter diameters from laterals in male, slightly farther apart in female. Chelicerae with two teeth on anterior margin. Total length of female 7.2 mm. Carapace 3.2 mm long, 2.5 mm wide. First femur, 5.4 mm; patella and tibia, 6.5 mm; metatarsus, 4.7 mm; tarsus, 1.6 mm. Second patella and tibia, 3.9 mm; third, 2.9 mm; fourth 4.4 mm. Total length of male 3.9 mm. Carapace 1.8 mm long, 1.6 mm wide. First femur, 3.7 mm; patella and tibia, 4.2 mm; metatarsus, 4.0 mm; tarsus, 1.4 mm. Second patella and tibia, 2.7 mm; third, 1.7 mm; fourth, 2.5 mm.

Variation. A specimen from Colombia is larger and shows slight differences in the palpus.

Diagnosis. The very dark coloration readily separates the species from most other *Theridion*. The female unaccompanied by the male might erroneously be placed in the genus *Achaearanea*. Unlike others of the *T. frondeum* group, the palpus has a ventral embolus (Fig. 37), being intermediate with species of the *T. murarium* group.

Records. Colombia. Narino: 25 km E of Santiago, 3 March 1955 (E. I. Schlinger, E. S. Ross, CAS). *Ecuador. Pichincha:* Quito, paramo, 3400 m, 25 April 1942, 3 ♀ (H. E. Frizzell).

Theridion stamotum sp. n.

Figures 40-41

Holotype. Male from Caracas, Venezuela, Dec. 1887 to Feb. 1888 (E. Simon), in the Muséum National d'Histoire Naturelle, Paris (no. 10877). The specific name is an arbitrary combination of letters.

Description. Carapace yellow-white with a narrow median longitudinal line and a fine gray border. Sternum, legs yellow-white. Abdomen grayish white with two rows of white spots, smaller white spots on sides and several gray spots on posterior portion of dorsum. Venter unmarked. Eyes subequal in size. Anterior median eyes their diameter apart, almost touching laterals. Posterior median eyes separated by two-thirds diameter, by one diameter from laterals. Chelicerae without teeth. Total length 1.3 mm. Carapace 0.60 mm long, 0.52 mm wide. First femur, 1.06 mm; patella and tibia, 1.14 mm; metatarsus, 0.78 mm; tarsus, 0.42 mm. Second patella and tibia, 0.71 mm; third, 0.50 mm; fourth, 0.64 mm.

Diagnosis. This species belongs to the *T. murarium* group. The shape of the median apophysis (Fig. 40) and of the radix (Fig. 41) separate it from *T. dividuum* Gertsch and Archer.

Theridion yuma sp. n.

Figures 42-43

Holotype. Male from Gila Valley, Yuma County, Arizona, 7 March 1956 (V. Roth) in the Museum of Comparative Zoology. The specific name is a noun in apposition after the type locality.

Description. Carapace yellowish with a narrow median black line, most distinct in the thoracic region; line around margin of carapace. Legs yellow-white with fine black bands at middle and ends of segments. Dorsum of abdomen with a median white band, its jagged margins bordered by dusky and black marks; venter with a black spot behind epigastric groove and a black spot on each side of epigastric area and one on each side of pedicel. Eyes subequal in size. Anterior median eyes one diameter apart, almost touching laterals. Posterior median eyes less than one diameter apart. Total length 1.2 mm. Carapace 0.58 mm long. First femur, 1.23 mm; patella and tibia, 1.50 mm; metatarsus, 1.06 mm; tarsus, 0.52 mm. Second patella and tibia, 0.84 mm; third, 0.55 mm; fourth, 0.78 mm.

Diagnosis. Theridion yuma has a shorter embolus and a larger conductor than *T. rabuni* Chamberlin and Ivie. It differs from *T. llano* Levi in the shape of the median apophysis (Figs. 42, 43).

Theridion utcuyacu sp. n.

Figures 47-49

Holotype. Male from Utcuyacu, Junín, Peru, 1600-2200 m elev. March 1948 (F. Woytkowski), in the American Museum of Natural History. The specific name is a noun in apposition after the type locality.

Description. Carapace yellowish with a median gray line and gray on sides. Sternum, legs yellow, except that distal ends of tibiae are black. Dorsum of abdomen with a well defined median band that is narrow at anterior where it is enclosed by two black areas, widest at the middle, and narrow behind. A narrow white line crosses band in middle. Venter of abdomen with a black spot anterior to spinnerets and another on the genital area. Eyes subequal in size. Anterior median eyes three-quarters diameter apart, one-quarter from laterals. Posterior median eyes their

radius apart, their diameter from laterals. Total length of female 3.0 mm. Carapace 1.3 mm long, 1.1 mm wide. Second patella and tibia, 1.5 mm; third, 1.1 mm; fourth, 1.5 mm. Total length of male 2.5 mm. Carapace 1.1 mm long, 1.0 mm wide. First femur, 2.2 mm; patella and tibia, 2.2 mm; metatarsus, 2.0 mm; tarsus, 0.7 mm. Second patella and tibia, 1.5 mm; third, 0.9 mm; fourth, 1.4 mm.

Diagnosis. The palpus, with its prominent median apophysis and heavy embolus (Fig. 47), separates this species from others of the *T. murarium* group. The internal connecting canals are sclerotized (Figs. 48, 49) and separate this species from others having two openings near the posterior margin of the epigynum (Fig. 49).

Records. ♀ paratype collected with holotype.

Theridion foliaceum Nicolet

Figures 44-46

Theridion foliaceum Nicolet, 1849, *in* Gay, Historia de Chile, 3: 538. Holotype from Chile, lost. Not *Theridion foliaceum* Hentz 1850 (=*Dictyna foliacea*).

Note. Nicolet's description of coloration matches this species. The placement, however, is not certain.

Description. Carapace yellowish with a dusky median band and a black line around margin. Sternum grayish. Legs yellow with narrow black rings around distal ends of tibiae and metatarsi. Abdomen with a median dorsal longitudinal white band having a wavy margin, being located in an area slightly darker, like other species of the *T. murarium* group. Sides and venter white. Abdomen of male darker than that of female. Eyes subequal in size. Anterior median eyes one and one-half diameters apart, one-third diameter from laterals. Posterior median eyes a little more than their diameter apart, one diameter from laterals. Epigynum a sclerotized plate, having a dark spot in each of a pair of shallow depressions (Fig. 46). The specimen from Paraguay has the internal portion of the sclerotized posterior rim longer, almost touching the ducts, and the seminal receptacles are slightly longer. The epigynum of the Paraguayan specimen has the posterior rim slightly narrow in the middle, and has a central sclerotized dark spot slightly anterior to openings. Total length of female 2.5 mm. Carapace 0.9 mm long, 0.8 mm wide. First femur, 1.3 mm; patella and tibia, 1.2 mm; metatarsus, 0.9 mm; tarsus, 0.5 mm. Second patella and tibia,

0.9 mm; third, 0.6 mm; fourth, 1.0 mm. Total length of male 2.4 mm. Carapace 1.04 mm long, 0.85 mm wide. First femur, 1.56 mm; patella and tibia, 1.75 mm; metatarsus, 1.36 mm; tarsus, 0.65 mm. Second patella and tibia, 1.14 mm; third, 0.69 mm; fourth, 1.07 mm.

Records. Argentina. Santa Cruz: Santa Cruz, ♀ ♂ (Silvestri, MNHN). *Chile. Linares:* Fundo Malcho, Cord. Parral, Dec. 1957, Feb., ♀ March 1958, ♂ (L. Peña, ISNB); Linares, Jan. 1947 (L. Peña, ISNB). *Bío-Bío:* 5 km W of Tucapel, 23 Dec. 1950 (E. S. Ross, A. E. Michelbacher, CAS); Laguna del Laja, 12-17 Jan. 1957 (L. Peña, ISNB). *Malleco:* Río Blanco, Caracautín, Feb. 1959 (L. Peña, ISNB). *Magallanes:* Laguna Amarga, Natales, Dec. 1960, ♀ (L. Peña).

Theridion linaresense sp. n.

Figures 50-51

Holotype. Female from Linares, Linares, Chile, Jan. 1947 (L. Peña) in the Institut Royal des Sciences Naturelles de Belgique in Brussels.

Description. Carapace rich yellow with gray marks on sides. Sternum yellow with indistinct gray sides. Legs yellow with darker yellow or gray rings at distal ends of segments. Dorsum of abdomen mottled white. Venter black anterior to pedicel, two black bands encircling a large white spot between genital groove and spinnerets. Spinnerets surrounded by a black ring with two short branches toward dorsum. Eyes subequal in size. Anterior median eyes one diameter apart, one-quarter diameter from laterals. Posterior eyes one diameter apart. Abdomen as wide as long, subtriangular. Total length 2.4 mm. Carapace 1.04 mm long, 0.56 mm wide. First femur, 0.92 mm; patella and tibia, 1.04 mm; metatarsus, 0.64 mm; tarsus, 0.32 mm. Second patella and tibia, 0.72 mm; third, 0.48 mm; fourth, 0.80 mm.

Diagnosis. This species is separated from *T. ambiguum* by the shape of the epigynum, a sclerotized plate containing two openings surrounded by black rims.

Record. 1 ♀ paratype collected with type.

Theridion penai sp. n.

Figures 52-53

Holotype. Female from Maullín, Llanquihue, Chile, 16-21 Feb. 1957 (L. Peña) in the Institut Royal des Sciences Naturelles de Belgique, Brussels. The species is named after the collector.

Description. Carapace, sternum, legs yellow-white. Dorsum of abdomen with a longitudinal white pigment band having straight sides. On sides of abdomen are several small round irregularly placed back spots and also white pigment spots. Venter of abdomen without white pigment spots, but with a large black spot anterior to spinnerets and sometimes a black spot on each side near middle. Eyes noticeably small, anterior median eyes slightly smaller than others. Anterior median eyes two diameters apart, almost one diameter from laterals; posterior eyes one diameter apart. One tooth on anterior margin of chelicerae. Total length of female 3.0 mm. Carapace 1.0 mm long, 0.9 mm wide. First femur, 1.9 mm; patella and tibia, 1.8 mm; metatarsus, 1.4 mm; tarsus, 0.6 mm. Second patella and tibia, 1.2 mm; third, 0.8 mm; fourth, 1.4 mm.

Diagnosis. This species differs from *T. calcynatum* by having heavily sclerotized lips around the epigynal opening (Fig. 53) and by having shorter connecting ducts (Fig. 52).

Records. Chile. Concepción: Menque, Feb. 1959 (L. Peña, ISNB). *Arauco:* Caramávida, Jan. 1954 (L. Peña, ISNB). *Malleco:* Icalma, Dec. 1958 (L. Peña, ISNB); Río Blanco, Caracautín, Feb. 1959 (L. Peña, ISNB). *Cautín:* Dalcahue, 10-12 Feb. 1954, ♀ (L. Peña, ISNB). *Llanquihue:* Maullín, 16-21 Feb. 1957, 2 ♀ paratypes (L. Peña, ISNB).

Theridion ambiguum Nicolet

Figures 54-58

Theridion ambiguum Nicolet, 1849, *in* Gay, Historia de Chile, 3: 532. Type from Chile, lost.

Note. Nicolet's description of coloration matches this species.

Description. Carapace yellow with a dusky median line. Sternum yellow-white. Legs yellow-white with darker bands, as wide as intermediate areas. Abdomen with a dorsal, longitudinal white band, having an irregular margin located in a dark area. Sides white, some white pigment posterior to epigynum on venter. Anterior median eyes smaller than others, one and one-half diameters apart, two-thirds diameter from laterals. Posterior median eyes three-quarters diameter apart, one diameter from laterals. Epigynum (Figs. 56, 58) with a depression, transparent, showing ducts on both sides, except in those specimens in which there is pigment present. Total length of female 2.2 mm. Carapace 1.04 mm long, 0.83 mm wide. First femur, 1.96 mm; patella and tibia, 2.06 mm; metatarsus, 1.46 mm.; tarsus, 0.65 mm. Second patella and tibia,

1.10 mm; third, 0.80 mm; fourth, 1.22 mm. Total length of male 2.0 mm. Carapace 0.93 mm long, 0.78 mm wide. Third patella and tibia, 0.70 mm; fourth, 1.04 mm.

Variation. The ducts and seminal receptacles of the female genitalia are variable. The seminal receptacles may be oval or spherical; the ducts may be coiled differently and the length of the flare at the external openings may differ. The ducts usually are black, but the black pigment may extend only a short distance from the seminal receptacles or may extend the whole length.

Records. Chile. Valparaíso: Cordillera Dept. Casablanca, 700-900 m, ♀ (MNHN). *O'Higgins:* Las Cabras, 1400 m (L. Peña, ISNB). *Linares:* Fundo Malcho Cord. Parral, ♀ (L. Peña, ISNB); Linares (L. Peña, ISNB); Las Cruces, Parral (L. Peña, ISNB). *Nuble:* Sierra Chillán (Germain, MNHN); Cobquecura (L. Peña, ISNB). *Arauco:* Pichinahuel, Cord. Nahuelbuta (L. Peña, ISNB). *Malleco:* Icalma (L. Peña, ISNB); Río Blanco, Curacautín (L. Peña, ISNB). *Cautín:* Dalcahue (L. Peña, ISNB). *Valdivia:* 30 km S of Valdivia (E. S. Ross, A. E. Michelbacher, CAS). *Llanquihue:* Los Muermos (E. S. Ross, A. E. Michelbacher, CAS); Carelmapu (L. Peña, ISNB). *Magallanes:* Bahía Inutil, ♂ (L. Peña); Camerón, ♀, ♂ (L. Peña).

Theridion nigroannulatum Keyserling

Figures 59-63

Theridium nigroannulatum Keyserling, 1884, Die Spinnen Amerikas, Theridiidae, 2(1): 74, pl. 4, fig. 45, ♀, ♂. Female lectotype here designated from Amable María, [640 m elev., Junín, prov. Tarma], Peru, in the Polish Academy of Sciences, Warsaw, examined.

Note on nomenclature. In Keyserling's key, page 5 and in the explanation of the illustrations the name *nigromaculatum* is used. However, Keyserling (1886, *op. cit.*, 2(2): 296) indicates that this was a misprint and that the name *nigroannulatum* should be used. Thus Bonnet (1959, Bibliographia Araneorum, 2: 4494) is in error in using the name *nigromaculatum* for this species.

Figures 61-63 were made from syntype specimens.

Diagnosis. The striking coloration, brownish with black patches (Fig. 63) and legs with black rings as wide as light rings, facilitates recognition of this species.

Natural history. Since all collections consisted of many individuals, it is suspected that this species is colonial or that

wherever found the population is dense.

Records. Peru. San Martín: Mishqui-yacu, 20 km NE of Moyobamba (R. Woytkowski). *Huánuco:* Cucharas Valley (F. Woytkowski); Tingo María (J. C. Pallister, AMNH); Monzón Valley, Tingo María (E. S. Ross, E. I. Schlinger, CAS); 24 km NE of Tingo María — "all from one colony."

Theridion rurrenabaque sp. n.

Figures 64-65

Holotype. Male from Rurrenabaque, Beni, Bolivia, Oct., Nov. 1958 (L. Peña) in the Institut Royal des Sciences Naturelles de Belgique, Brussels. The specific name is a noun in apposition after the type locality.

Description. Carapace, sternum, legs orange-yellow with ends of femora and tibiae grayish. Abdomen dull orange-yellow with a black spot above spinnerets. Anterior median eyes slightly smaller than others, one and one-quarter diameters apart, one diameter from laterals. Posterior eyes their diameter apart. Chelicerae with two teeth on the anterior margin. Total length of male 2.5 mm. Carapace 1.3 mm long, 1.1 mm wide. First femur, 3.3 mm; patella and tibia, 3.4 mm; metatarsus, 3.2 mm; tarsus, 1.0 mm. Second patella and tibia, 1.9 mm; third, 1.0 mm; fourth 1.8 mm.

Diagnosis. This species is very similar to *T. chacoense* but differs in having a slightly shorter median apophysis, a more prominent embolus, a larger tegulum, and shorter conductor (Figs. 64, 65). It lacks the notch in the subtegulum present in *T. nigroannulatum.*

Theridion longipedatum Roewer

Figures 66-67

Theridium longipes Keyserling, 1884, Die Spinnen Amerikas, Theridiidae, 2(1): 66, pl. 3, fig. 40, ♀. Female holotype from Santa Fe de Bogota [Bogota], Colombia, in the British Museum, examined. Name preoccupied by *T. longipes* Hasselt, 1882.

Theridion longipedatum Roewer, 1942, Katalog der Araneae, 1: 494. New name for *T. longipes* Keyserling, preoccupied.

Although this species has an epigynum resembling *Achaearanea taeniata* (Keyserling), it is light colored, has long legs, and belongs to the *T. frondeum* group. Figures 66-67 were prepared from the holotype.

Theridion aragua sp. n.

Figures 68-71

Holotype. Male from Tovar, Aragua, Venezuela, January to February 1888 (E. Simon), in the Muséum National d'Histoire Naturelle, Paris (no. 11640). The specific name is a noun in apposition after the Venezuelan state.

Description. Color very variable. Carapace yellowish, sometimes with a median longitudinal band as wide as eye region in front, pointed behind. Sternum yellow. Legs yellow, sometimes with dark spots on underside. Abdomen variable, sometimes with a median longitudinal dorsal white line or dark band, always with many white and black patches; venter yellowish, sometimes gray. Eyes of male subequal in size. Anterior median eyes three-quarters diameter apart, almost touching laterals. Posterior median eyes three-quarters diameter apart, one diameter from laterals. Anterior median eyes of female slightly smaller than others, their diameter apart, one-quarter diameter from laterals. Posterior median eyes two-thirds diameter apart, three-quarters diameter from laterals. Chelicerae with one large tooth and a small one between it and base of fang. Abdomen subspherical. Total length of female 2.2 mm. Carapace 0.8 mm long, 0.8 mm wide. First femur, 1.1 mm; patella and tibia, 1.1 mm; metatarsus, 0.9 mm; tarsus, 0.5 mm. Second patella and tibia, 0.8 mm; third, 0.6 mm; fourth 1.0 mm. Total length of male 1.9 mm. Carapace 0.9 mm long, 0.9 mm wide. First femur, 1.4 mm; patella and tibia, 1.8 mm; metatarsus, 1.3 mm; tarsus, 0.6 mm. Second patella and tibia, 1.2 mm; third, 0.7 mm; fourth, 0.9 mm.

Diagnosis. The male can be separated from other species of the *T. frondeum* group by the tegulum shape and the U-shaped embolus (Fig. 71). The epigynum has two openings side by side, each in a black spot; the black spots are on a raised area which is projecting from the abdomen (Fig. 69).

Records. ♀, ♂ paratypes collected with holotype.

Theridion grandiosum sp. n.

Figures 72-75

Holotype. Male from 48 km east of Carhuamayo, Junín, Peru, 30 Dec. 1954 (E. I. Schlinger, E. S. Ross), in the California Academy of Sciences. The specific name is an arbitrary combination of letters.

Description. Carapace yellow-brown, reddish in head region. Sternum yellow-brown with a red-brown line around margin. Legs yellow-brown with red-brown bands as wide as intermediate areas. Abdomen gray-brown with three connected brown spots on middle of dorsum and three to five large brown spots on each side with some small white pigment spots in between and also some smaller brown spots, but quite variable in different specimens. Genital region brown, a white area posterior, and a brown area anterior to spinnerets. In larger females the pattern becomes indistinct and the spots may run into each other. Anterior median eyes slightly larger than others, their diameter apart in male, and one-quarter diameter from laterals. Posterior median eyes one diameter apart, one and one-half diameters from laterals. Eyes of female not quite as large and farther apart. Chelicerae with one broad tooth on promargin in male, two in female. Total length of female 8.0 mm. Carapace 2.9 mm long, 2.4 mm wide. First femur, 4.9 mm; patella and tibia, 5.6 mm; metatarsus, 4.1 mm; tarsus, 1.6 mm. Second patella and tibia, 3.9 mm; third, 2.6 mm; fourth, 4.0 mm. Total length of male 5.5 mm. Carapace 2.5 mm long, 2.4 mm wide. First femur, 4.5 mm; patella and tibia, 5.5 mm; metatarsus, 4.0 mm; tarsus, 1.9 mm. Second patella and tibia, 3.7 mm; third, 2.3 mm; fourth, 3.4 mm.

Diagnosis. The very large size and the distinct genitalia separate this species from *T. morulum* O. P.-Cambridge. Unlike other species of the *T. frondeum* group, the epigynum has a large protuberance bending anteriorly. The embolus is very large and has moved ventrally pushing the tegulum to the side; it is supported by the conductor (Fig. 75).

Record. Peru. Junín: Carhuamayo, 4 ♂ and 5 ♀ paratypes collected with type. *Huánuco:* Carpish Mts., 62 km NE of Huánuco, 28 Dec. 1954, ♀ (E. I. Schlinger, E. S. Ross, CAS).

Theridion triguttatum Keyserling

Figures 76-77

Theridium triguttatum Keyserling, 1891, Die Spinnen Amerikas, Brasilianische Spinnen, 3: 190, pl. 6, fig. 136, ♀. Female syntypes from Neu Freiburg [Nova Friburgo, Est. Rio de Jan.] and Espírito Santo on the Rio Minas, Brazil, in the British Museum, examined.

This species is orange in coloration. Figures 76, 77 were prepared from a syntype.

Records. Brazil. Guanabara: Sumaré, Rio de Janeiro, Feb. 1946 (H. Sick, AMNH). *Est. Rio de Janeiro:* Teresópolis,

March 1946 (H. Sick, AMNH). *São Paulo:* Ribeirão Pires, Dec. 1945 (H. Sick, AMNH).

Theridion uber Keyserling

Figures 78-79

Theridium uber Keyserling, 1884, Die Spinnen Amerikas, Theridiidae, 2(1): 51, pl. 2, fig. 29, ♀. Female holotype from Prov. Amazonas, Brazil, in the Hope Department of Entomology, Oxford University, examined.

The abdomen of this species is wider than long. Figures 78, 79 were prepared from the holotype.

Theridion rufipunctum Levi

Figures 80-81

Theridion rufipunctum Levi, 1959, Bull. Mus. Comp. Zool., 121: 118, figs. 230-233, ♀ ♂. Male holotype from Panama, in the Museum of Comparative Zoology.

Note. The specimen collected in Ecuador has the posterior rim of the epigynum more sclerotized (Fig. 81) than in Panamanian specimens. The abdomen of this species is wider than long; the patellae have black spots on their anterior face.

Records. Ecuador. Tungurahua: Mt. Tungurahua, 1900-2000 m, 10 April 1939, ♀ (W. C. Macintyre).

Theridion sexmaculatum Keyserling

Map 3

Theridium sexmaculatum Keyserling, 1884, Die Spinnen Amerikas, Theridiidae, 2(1): 82, pl. 4, fig. 51, ♀. Female syntypes from Amazonas, Brazil, in the Hope Department of Entomology, Oxford University, examined. —Levi, 1959, Bull. Mus. Comp. Zool., 121: 119, figs. 236-239, ♀, ♂.

Distribution. West Indies, Guatemala, Panama, Venezuela, Ecuador, Lower Amazon Valley (Map 3).

Additional records. Haiti: La Boule, Nov. 1959, ♀, ♂ (A. M. Nadler, AMNH). *Venezuela. Aragua:* Rancho Grande (A. M. Nadler, AMNH). *Ecuador. Guayas:* Milagro (H. E., D. L. Frizzell).

Theridion cocosense Strand

Figures 82-83

Theridium sp. Banks, 1905, Proc. Ent. Soc. Washington, 7:21, from the Coco Isl. The specimens referred to have not been found.

Theridion cocosense Strand, 1906, Zool. Zentralbl., 13: 783. Name for *Theridium* sp. Banks.

Note. Giving the specimen on hand Strand's name may be arbitrary, but it came from the type locality. Banks' total description reads: "A few specimens of a small species, with a short yellow abdomen and a black cephalothorax. Quite possibly it is new." It was probably an immature spider later discarded.

Description. Whitish without any pigment except in eyes. Anterior median eyes slightly smaller than others, one diameter apart, less than one diameter from laterals. Posterior median eyes one diameter apart, less than one diameter from laterals. Chelicerae with one tooth on anterior margin. Abdomen suboval, twice as long as wide. Total length 3.0 mm. Carapace 1.1 mm long, 1.0 mm wide. First femur, 3.5 mm; patella and tibia, 3.5 mm; metatarsus, 4.0 mm; tarsus, 0.9 mm. Second patella and tibia, 2.0 mm; third, 1.2 mm; fourth 2.3 mm.

Diagnosis. Epigynum is weakly sclerotized and indistinct (Fig. 83). Internal genitalia also very weakly sclerotized. The ducts loop (Fig. 82) as in other species of the *T. frondeum* group. It differs from others by the greater extent of the loop, and by the shape of the lips around the opening (Fig. 83).

Records. Costa Rica: Isla del Coco, lat 5°32′N, long 87°40′W, 1 ♀ (AMNH).

Theridion onticolum sp. n.

Figures 84-85

Holotype. Female from the small mountain Cerro Negro, Piura, Peru, 15 June 1941 (H. E. and D. L. Frizzell) in the Museum of Comparative Zoology. The specific name is an arbitrary combination of letters.

Description. Carapace brownish; sternum yellow, dusky around margin; legs yellow. Abdomen with some large white pigment spots on dorsum and two rows of three to four large black spots. Shape of abdomen oval, longer than wide or high. Anterior median eyes considerably smaller than others. Anterior median eyes one and one-half diameters apart, two-thirds diameter from laterals. Posterior eyes three-quarters diameter apart. Total length 1.9 mm. Carapace 0.78 mm long, 0.78 mm wide. First femur, 1.19 mm; patella and tibia, 1.19 mm; metatarsus, 0.98 mm; tarsus, 0.48 mm. Second patella and tibia, 0.89 mm; third, 0.68 mm; fourth, 1.04 mm.

Diagnosis. The epigynum, which has a small depression with a very thick lip all around close to the border (Fig. 85), and the

internal genitalia (Fig. 84), separate this species from others. It is not known to which species group *T. onticolum* belongs.

Theridion amatitlan sp. n.

Figures 88-89

Holotype. Female from Amatitlán, Guatemala, 24 Aug. 1947 (C. and P. Vaurie), in the American Museum of Natural History. The specific name is a noun in apposition after the type locality.

Description. Carapace dark brown, sternum brown, legs brown. Abdomen dark gray without pattern. Eyes subequal in size. Anterior median eyes one diameter apart, their radius from laterals. Posterior median eyes their diameter apart, a little more than their diameter from laterals. Total length 3.6 mm. Carapace 1.17 mm long, 0.99 mm wide. First femur, 1.32 mm; patella and tibia, 1.36 mm; metatarsus, 1.05 mm; tarsus, 0.60 mm. Second patella and tibia, 1.23 mm; third, 1.01 mm; fourth, 1.23 mm.

Diagnosis. It is uncertain to which species group this species belongs. No species is close to it. Epigynum a small, dark sclerotized spot at the posterior edge of a larger, lighter sclerotized area. Area posterior to spot light in color, sides with gray pigment (Fig. 89).

Theridion pelaezi sp. n.

Figures 90-91

Holotype. Female from Río Frío, Puebla, 3000 m elev., Mexico, 26 April 1942 (C. Bolivar, B. Osorio, D. Pelaez), in the American Museum of Natural History.

Description. Carapace yellow-white with a narrow black line around margin, a gray median band as wide as posterior median eyes in front, narrow behind. Sternum, legs yellow-white with a dark distal area on tibiae and metatarsi. Abdomen yellow-white with small white pigment spots on dorsum more dense in a median line, and pair of black spots above spinnerets. Eyes subequal in size. Anterior median eyes one diameter apart, their radius from laterals. Posterior median eyes one diameter apart, one and one-quarter diameters from laterals. Chelicerae with two teeth on anterior margin. Total length 4.0 mm. Carapace 1.5 mm long, 1.3 mm wide. Second patella and tibia, 1.8 mm; fourth 2.0 mm.

Diagnosis. The epigynum has a depression anterior to a sclerotized fold (Figs. 90-91) quite similar to *T. frio*. *Theridion frio*

differs by having two ventral black spots on the abdomen, by having the ducts visible in the posterior portion of the epigynum, having the anterior sclerotized edge curved, and having the seminal receptacles almost twice as long as wide (Levi, 1959, figs. 199, 200). The openings of the epigynum in *T. frio* are on each end on the raised portion of the epigynum.

Theridion ecuadorense sp. n.

Figures 92-93

Holotype. Female from a copper mining camp inland from Palenque River, Los Rios, Ecuador, March 1943 (H. E. Frizzell), in the Museum of Comparative Zoology. The species is named after the country of the type locality.

Description. Carapace dark olive-brown. Sternum brown, anterior yellowish. Legs dark yellow with brown patches. Abdomen covered by small white pigment spots and several large black streaks going down sides and behind towards spinnerets. A white inverted T behind genital groove on black background on venter. Anterior median eyes slightly larger than others, two-thirds their diameter apart, their radius from laterals. Posterior eyes one diameter apart. Chelicerae with two teeth on anterior margin. Total length 5.4 mm. Carapace 1.6 mm long, 1.5 mm wide. First femur, 3.2 mm; patella and tibia, 3.3 mm; metatarsus, 2.7 mm; tarsus, 1.1 mm. Second patella and tibia, 2.3 mm; third, 1.5 mm; fourth, 2.5 mm.

Diagnosis. The epigynum has a heavily sclerotized transverse depression (Fig. 93). The looping ducts as well as the wide depression of the epigynum separate this large species from others. It is possible that the species belongs in the genus *Achaearanea*.

Theridion oswaldocruzi sp. n.

Figures 94-95

Holotype. Female from Instituo Oswaldo Cruz, Cidade Rio de Janeiro, Guanabara, Brazil, 23 Jan. 1959 (A. M. Nadler), in the American Museum of Natural History. The species is named after Oswaldo Cruz.

Description. Carapace, sternum, legs yellowish. Abdomen, yellowish white with two thin white, longitudinal lines on dorsum, separated by more than twice their width and meeting above spinnerets. Also, many small white spots on dorsum. No marks on venter. Anterior median eyes slightly smaller than others, a little more than their diameter apart, touching laterals. Posterior median eyes two-thirds diameter apart, their radius from

laterals. Total length 1.5 mm. Carapace 0.57 mm long, 0.55 mm wide. First femur, 1.26 mm; patella and tibia, 1.31 mm; metatarsus, 1.03 mm; tarsus, 0.45 mm. Second patella and tibia, 0.85 mm; third, 0.53; fourth, 0.87 mm.

Diagnosis. The epigynum, which has a sclerotized over-hanging lip near the posterior margin, and whose openings are near the center anterior to the lip (Fig. 95), distinguish this species readily from other *Theridion*. The connecting ducts are relatively long (Fig. 94).

Theridion aeolium sp. n.

Figures 96-97

Holotype. Female from 1.1 road miles above Windy Point, 2000 m elev., Santa Catalina Mountains, Pima County, Arizona, under rock, 22 Oct. 1959 (J. A. Beatty), in the Museum of Comparative Zoology. The specific name is an adjective meaning windy.

Description. Carapace light olive-brown with gray pigment unevenly distributed, reddish near eyes. Sternum dark gray with sides black. Legs whitish with narrow black bands, broken on dorsum. Dorsum of abdomen with white pigment; anterior a black mark above carapace, two dark marks on each side above spinnerets, and two faint parallel gray longitudinal marks. Sides with some gray pigment. Venter with a white pigment spot behind epigynum. Anterior median eyes slightly larger than others, two-thirds diameter apart, almost touching laterals. Posterior median eyes two-third diameter apart, three-quarters diameter from laterals. Total length 1.4 mm. Carapace 0.60 mm long, 0.60 mm wide. First femur, 0.96 mm; patella and tibia, 1.02 mm; metatarsus, 0.72 mm; tarsus, 0.41 mm. Second patella and tibia, 0.71 mm; third, 0.50 mm; fourth, 0.75 mm.

Diagnosis. The epigynum has a median longitudinal depression containing a dark longitudinal mark (Fig. 97); on each side of the depression is a swollen area bearing about eight to ten setae (setae not shown in Fig. 97). *Theridion aeolium* seems close to *T. timpanogos* Levi but differs by the lateral swellings on the epigynum.

Theridion colima Levi

Theridion colima Levi, 1959, Bull. Mus. Comp. Zool., 121(3): 136, figs. 277-279, ♀. Female type from Colima, Mexico, in the American Museum of Natural History.

Records. Ecuador. Tungurahua: Baños, 2200 m, 29 Apr. 1939 (W. C. Macintyre), doubtful determination.

Theridion eremum sp. n.

Figures 98-99

Holotype. Female from Nova Teutonia, lat 27°11′S, long 52°23′W, Santa Catarina, Brazil (F. Plaumann), in the Senckenberg Museum (no. RII/13471/1). The specific name is an arbitrary combination of letters.

Description. Carapace yellow. Sternum grayish yellow. Legs yellow. Dorsum of abdomen with two large dark black areas anterior and two large black areas posterior; a colorless cross in a central area of fine white pigment spots; venter without pigment. Anterior median eyes slightly larger than others, one diameter apart, their radius from laterals. Posterior median eyes one-third diameter apart, almost one diameter from laterals. Total length 1.7 mm. Carapace 0.78 mm long, 0.70 mm wide. First femur, 0.84 mm; patella and tibia, 0.70 mm; metatarsus, 0.43 mm; tarsus, 0.39 mm.

Diagnosis. The very distinct epigynum (Fig. 99) has two lateral dark areas, the shadows of the connecting ducts, which readily separate this species from other *Theridion.*

Theridion calcynatum Holmberg

Figures 100-107; Map 3

Theridion calcynatum Holmberg, 1876, An. Agr. Rep. Argentina, 4: 72. Types from Argentina lost. However, some female specimens sent by Holmberg to Keyserling and belonging to the British Museum were examined.

Theridium calycinatum, — Keyserling, 1884, Die Spinnen Amerikas, Theridiidae, 2(1): 72, fig. 44, ♀, ♂. Bonnet, 1959, Bibliographia Araneorum, 2: 4499.

Theridium limaense Keyserling, 1884, *op. cit.* 2(1): 76, pl. 4, fig. 46, ♀, ♂. Male lectotype here designated from Lima, Peru, in the Polish Academy of Science, Warsaw, examined. NEW SYNONYMY.

Notes. Keyserling (1884) misspelled the name of the species and referred to the wrong Holmberg page number. Both errors have been repeated by Petrunkevitch and in all the subsequent literature. The original publication is extremely rare and no copies are in this country, and none, presumably, in Europe. A microfilm of Holmberg's publication has been obtained through the courtesy of Dr. Gravenstein, librarian in Buenos Aires.

Despite being called *limaense,* Keyserling does not refer to Lima as type locality. This I believe is an omission since specimens from the type collection came from Lima. Figures 102-103, 106-107 were made from the syntypes from Peru.

Description. Female carapace yellow-white often with a median black band. Sternum sometimes black, sometimes colorless. Legs yellow-white, sometimes with black spots. Abdomen yellow-white, dorsum usually white with some black marks, but no two specimens have the black marks in the same area. Anterior median eyes slightly smaller than others, one and one-half diameters apart, one diameter from laterals. Posterior median eyes one diameter apart, one and one-quarter diameter from laterals. Chelicerae with two teeth on anterior margin. Total length of female from Argentina 5.0 mm. Carapace 2.0 mm long, 1.4 mm wide. First femur, 4.8 mm; patella and tibia, 5.2 mm; metatarsus, 5.2 mm; tarsus, 1.4 mm. Second patella and tibia, 3.0 mm; third, 2.5 mm; fourth, 3.2 mm. Total length of male from Argentina, 4.7 mm. Carapace 2.3 mm long, 1.5 mm wide. First femur, 5.5 mm; patella and tibia 6.2 mm; metatarsus, 6.9 mm; tarsus, 1.5 mm. Second patella and tibia, 3.2 mm; third, 1.9 mm; fourth, 3.2 mm.

Figures 104, 105 were made from specimens sent to Keyserling by Holmberg. Figures 100-101 were made from a male from Argentina.

The color of this species is very variable. The venter may have a pair of black spots. Brazilian specimens often have a lip on the posterior margin of the epigynum depression.

Natural history. This species has been collected "in webs underneath leaves in shrubs" by W. Weyrauch at Divisoria Cordillera, Peru, 1600 m elev.

Distribution. South America from Venezuela to Argentina, outside of Chile (Map 3).

Records. Venezuela. Dist. Fed.: Caracas, 1887-1888 (E. Simon, MNHN). *Mérida:* Mucutuy, 1600 m, ♂ (J. T. H., BMNH). *Ecuador. Tungurahua:* Baños (E. I. Schlinger, E. S. Ross, CAS). *Chimborazo:* 48 km SW of Alausi (E. I. Schlinger, E. S. Ross, CAS). *Peru. Piura:* Las Lomas Higueron (H. E., D. L. Frizzell); Pariñas Vall. (H. E., D. L. Frizzell); Quebrada Mogollón (H. E., D. L. Frizzell). *San Martín:* Mishqui-yacu, 20 km NE of Moyobamba (F. Woytkowski). *Libertad:* Hacienda Cartavio, near Trujillo (W. Weyrauch, AMNH). *Huánuco:* Tingo María (W. Weyrauch, AMNH). *Ancash:* Recuay (Huarez); Valle Santa, 3400 m (W. K. W.). *Junín:* Utcuyacu,

1600-2000 m (F. Woytkowski); Huacapistana, Río Tarma, 1800 m (W. Weyrauch, AMNH). *Lima:* Lima, paratypes; (W. Weyrauch, AMNH). *Cuzco:* Machu Picchu, Pueblo Cuzco (J. C. Pallister, AMNH); Quillabamba, Valle Urubamba (W. Weyrauch, AMNH). *Brazil. Minas Gerais:* Minha Serinha, Diamantina (E. Cohn, AMNH); Ouro Prêto (N. L. H. Krauss, AMNH); near Patrocínio (G. Andrews); Bello Horizonte (Cornell Univ. Exped.). *Est. Rio de Janeiro:* Teresópolis (E. Göldi, MNHN; H. Sick, AMNH); Petrópolis, 850 m (H. Sick, AMNH). *Guanabara:* Sumaré, Rio de Janeiro, 200-300 m (H. Sick, AMNH). *Est. São Paulo:* São Paulo (A. M. Nadler; N. L. H. Krauss, AMNH). *Paraná:* Rolândia (A. Maller, AMNH). *Santa Catarina:* Nova Teutonia, lat 27°11′S, long 52°23′W (F. Plaumann, SMF). *Rio Grande do Sul:* Pelotas (C. Biezanko, AMNH). *Bolivia.* Chaco, 2000 m (MNHN). *La Paz:* Chulumani, 1700 m (L. Peña, ISNB); Villa Yungas (L. Peña, ISNB). *Argentina. Buenos Aires:* Punta Lara, ♀ ♂ (M. Birabén).

Theridion frizzellorum sp. n.

Figures 109-116

Holotype. Male from Baños, Tungurahua Prov., Ecuador, 15-21 June 1943 (H. E. and D. L. Frizzell), in the Museum of Comparative Zoology. The species is named after the collectors.

Description. Carapace, sternum yellow-white. Legs yellow-white with some dusky marks on middle and ends of segments. Abdomen with dorsum white, but often having black patches; otherwise yellow-white. Eyes subequal in size. Anterior median eyes one and one-half diameters apart, one diameter from laterals. Posterior median eyes their diameter apart, one and one-half diameters from laterals. Male with chelicerae slightly enlarged and having a boss at their proximal end. Chelicerae of female without boss, and with two teeth on anterior margin. Total length of female 4.7 mm. Carapace 1.6 mm long, 1.2 mm wide. First femur, 3.3 mm; patella and tibia, 3.2 mm; metatarsus, 3.1 mm; tarsus, 0.8 mm. Second patella and tibia, 2.2 mm; third, 1.3 mm; fourth, 2.4 mm. Total length of male 3.6 mm. Carapace 1.7 mm long, 1.3 mm wide. First femur, 4.3 mm; patella and tibia, 4.2 mm; metatarsus, 4.4 mm; tarsus, 1.1 mm. Second patella and tibia, 2.4 mm; third, 1.4 mm; fourth, 2.5 mm.

Variation. The ducts visible through the tegulum of the male palpus and the shape of the median apophysis are slightly different in each male examined. Some specimens collected together

lack the lower lobe of the median apophysis; in others it is longer than in Figure 111. The shape of the depression of the epigynum is also somewhat variable.

Diagnosis. The epigynum (Figs. 114, 116) has a subtriangular depression with two darker areas and is quite indistinct. The internal female genitalia (Figs. 113, 115) are sclerotized, the seminal receptacles are large and of a different shape, the connecting ducts differ in their course from those of *T. calcynatum*. The shape of the embolus, the median apophysis of the palpus and the ducts in the tegulum (Figs. 109, 110) separate this species from *T. calcynatum*. However, the median apophysis (Fig. 109) is variable in shape.

Records. Venezuela. Mérida: Mérida, ♀ (SMF). *Colombia. Antioquia:* Medellín, 1700-2000 m (P. B. Schneble). *Cundinamarca:* Bogotá, ♀ ♂ (BMNH). *Ecuador. Tungurahua:* Baños, 7 May 1942; 15-21 June 1943, ♀ ♂ paratypes (H. E., D. L. Frizzell); Puñapí, 19 June 1943 (H. E., D. L. Frizzell); Pastaza Vall., between Baños and Mero, 1949, ♀ (W. C. Macintyre); Mt. Tungurahua, 1900-2000 m, 10 Apr. 1939 (W. C. Macintyre).

Theridion botanicum sp. n.

Figures 117-120

Holotype. Male from Botanical Gardens, Caracas, Venezuela, 15 Dec. 1954 (A. M. Nadler), in the American Museum of Natural History. The specific name is an arbitrary combination of letters.

Description. Carapace yellow-white with a narrow black median line. Sternum, legs yellow-white. Abdomen yellow-white with a white median dorsal band, whose edges are scalloped. A black mark on venter above and anterior to pedicel and a pair of black spots above spinnerets. The female has some white patches on sides of abdomen. Anterior median eyes slightly smaller than others, one and one-half diameters apart, two-thirds diameter from laterals. Posterior eyes slightly more than their diameter apart. Total length of female 2.3 mm. Carapace 0.50 mm long, 0.37 mm wide. First femur, 1.00 mm; patella and tibia, 1.04 mm; metatarsus, 0.90 mm; tarsus, 0.33 mm. Second patella and tibia, 0.57 mm; third, 0.39 mm; fourth, 0.72 mm. Total length of male 2.0 mm. Carapace 0.49 mm long, 0.38 mm wide. First femur, 1.05 mm; patella and tibia, 1.18 mm; metatarsus, 1.03 mm; tarsus, 0.37 mm. Second patella and tibia, 0.47

mm; third, 0.33 mm; fourth, 0.65 mm.

Diagnosis. This species, belonging to the *T. frondeum* group, is difficult to separate from others. The epigynum has a central, dark spot, having within the spot two darker marks (Fig. 118), and on each side of the epigynum is a gray mark; the connecting ducts (Fig. 117) are longer than those of *T. frizzellorum*. The palpus may be separated from those of other species by the ducts in the tegulum, by the shape of the embolus (Fig. 120) and by the proximal prong of the median apophysis which has a nick at its tip (Fig. 119).

Record. Venezuela. Dist. Fed.: Caracas, ♀ paratype collected with holotype; 1887-1888, ♀ (E. Simon, MNHN).

Theridion grecia Levi

Map 3

Theridion grecia Levi, 1959, Bull. Mus. Comp. Zool., 121(3): 105, figs. 185-186, ♀. Female type from Costa Rica in the American Museum of Natural History.

Distribution. Mexico to Venezuela (Map 3).

Theridion evexum Keyserling

Map 2

Theridium evexum Keyserling, 1884, Die Spinnen Amerikas, Theridiidae, 2(1): 65, pl. 3, fig. 39, ♀. Female type from N. Granada [Ecuador, Colombia, Venezuela, and Panama] in the British Museum, examined. — Levi, 1959, Bull. Mus. Comp. Zool., 121: 97, figs. 124-135, map 5.

Distribution. Southern Mexico, Central America, West Indies, Colombia, Venezuela and southern Brazil (Map 2).

Additional records. Venezuela. Aragua: Tovar, 1888 (E. Simon, MNHN). *Colombia. Cauca:* 24 km S of Corinto, March 1955 (E. I. Schlinger, E. S. Ross, CAS).

Theridion huanuco sp. n.

Figure 108

Holotype. Male from Tingo María, Huánuco, Peru, 20 Jan. 1947 (J. C. Pallister), in the American Museum of Natural History. The specific name is a noun in apposition after the type locality.

Description. Carapace, legs yellow-white. Sternum with a black spot on posterior portion. Abdomen with a median white band, having scalloped margins. Eyes small, subequal in size.

Anterior median eyes one and one-half diameters apart, one diameter from laterals. Posterior median eyes one diameter apart, one and one-quarter diameters from laterals. Total length 2.2 mm. Carapace 1.1 mm long, 0.8 mm wide. First femur, 3.0 mm; patella and tibia, 2.9 mm; metatarsus, 2.9 mm; tarsus, 0.8 mm. Second patella and tibia, 1.7 mm; third, 0.9 mm; fourth, 1.4 mm.

Diagnosis. The huge prong of the median apophysis of the palpus (Fig. 108) separates this species from other species of the *T. frondeum* group.

Theridion chacoense sp. n.

Figures 121-122

Holotype. Male from Chaco, 2000 m elev., Bolivia, in the Muséum National d'Histoire Naturelle, Paris (no. 18023). The species is named after the type locality.

Description. Carapace, sternum, legs yellow-brown. Abdomen (which is slightly damaged in the only specimen) gray with some scarce white and black pigment on the sides. Eyes subequal in size. Anterior median eyes one and one-quarter diameters apart, one diameter from laterals. Posterior median eyes one diameter apart, one and three-quarters from laterals. Two teeth on anterior margin of chelicerae. Legs appearing quite hairy. Total length 3.0 mm. Carapace 1.3 mm long, 1.0 mm wide. First femur, 3.2 mm; patella and tibia, 3.1 mm; metatarsus, 3.2 mm; tarsus, 1.0 mm. Second patella and tibia, 1.8 mm; third, 1.1 mm; fourth, 1.8 mm.

Diagnosis. The shape of the palpal bulb, the very large conductor (Fig. 122) and the embolus which is not visible in ventral view separate this species from the similar *T. rurrenabaque,* also found in Bolivia.

Theridion cochise sp. n.

Figures 123-124

Holotype. Male from Southwestern Research Station, 5 mi. west of Portal, Cochise County, Arizona, July 1955 (J. W. Gertsch), in the American Museum of Natural History. The specific name is a noun in apposition after the county of the type locality.

Description. Carapace, sternum, legs yellow. Abdomen white with two rows of gray marks on dorsum. Eyes subequal in size.

Anterior eyes one diameter apart. Posterior median eyes one diameter apart, one and one-half diameters from laterals. Total length 3.5 mm. Carapace 1.5 mm long, 1.4 mm wide. First femur, 3.4 mm; patella and tibia, 4.1 mm; metatarsus, 3.2 mm; tarsus, 1.2 mm. Second patella and tibia, 2.6 mm; third, 1.9 mm; fourth, 2.4 mm.

Diagnosis. This species is very similar to *T. morulum* O. P.-Cambridge; however, the shape of the embolus and median apophysis (Fig. 124) differs. The female is not known.

Record. ♂ paratype from type locality, 5-15 Aug. 1955 (W. J. Gertsch, AMNH).

Theridion tebanum sp. n.

Figures 125-126

Holotype. Male from San Esteban, Carabobo, Venezuela, March 1888 (E. Simon), in the Muséum National d'Histoire Naturelle, Paris (no. 11700). The specific name is an arbitrary combination of letters.

Description. Carapace, sternum, legs yellow-white. Abdomen whitish with a pair of circular black spots on posterior of dorsum. Anterior median eyes slightly smaller than others, their diameter apart, three-quarters their diameter from laterals. Posterior median eyes their diameter apart, three-quarters diameter from laterals. Chelicerae without boss below clypeus and with two teeth on the anterior margin. Abdomen relatively long. Total length 3.0 mm. Carapace 1.0 mm long, 0.9 mm wide. First femur, 2.9 mm; patella and tibia, 2.9 mm; metatarsus, 2.8 mm; tarsus, 0.9 mm. Second patella and tibia, 1.6 mm; third, 0.7 mm; fourth, 1.4 mm.

Diagnosis. The ducts and shape of tegulum and median apophysis (Figs. 125-126) separate this species from others of the *T. frondeum* group.

Theridion ravum sp. n.

Figures 127-130

Holotype. Male from Tovar, Aragua, Venezuela, Jan. to Feb. 1888 (E. Simon), in the Muséum National d'Histoire Naturelle, Paris (no. 11634). The specific name is an arbitrary combination of letters.

Description. Carapace of male yellow with two parallel lines;

female with a black band having parallel sides. Sternum yellow. Legs yellow, female with black spots on venter of legs. Abdomen of male with median dorsal longitudinal white band, white spots on sides, and several black spots on side of band. Female similar but darker, having more black. Genital area of both sexes black. Female has a black spot between genital area and spinnerets. Eyes subequal in size. Anterior median eyes separated by one and one-half their diameters, one diameter from laterals. Posterior median eyes their diameter apart, one and one-half diameters from laterals, in male; one diameter in female. Chelicerae of male with a boss below clypeus. Male with one tooth on anterior margin, female with two. Total length of female 2.9 mm. Carapace 1.3 mm long, 1.1 mm wide. First femur, 2.0 mm; patella and tibia, 2.3 mm; metatarsus, 2.0 mm; tarsus, 0.8 mm. Second patella and tibia, 1.4 mm; third, 0.9 mm; fourth, 1.8 mm. Total length of male 3.0 mm. Carapace 1.4 mm long, 1.3 mm wide. First femur, 3.0 mm; patella and tibia, 3.5 mm; metatarsus, 3.0 mm; tarsus, 1.0 mm. Second patella and tibia, 2.0 mm; third, 1.1 mm; fourth, 1.9 mm.

Diagnosis. This species differs from others of the *T. frondeum* group by the shape of the tegulum and its ducts (Fig. 128) and by the shape of the epigynum which has a central depression, and has the posterior margin heavily sclerotized and containing the openings (Fig. 130).

Records. 3 ♀ paratypes collected with holotype.

Theridion unanimum Keyserling
Figures 131-134; Map 2

Theridium unanimum Keyserling, 1891, Die Spinnen Amerikas, Brasilianische Spinnen, 3: 181, pl. 6, fig. 126, ♀, ♂. Male and female syntypes from Neu Freiburg [Nova Friburgo, Est. Rio de Jan.] and Fazenda Serra Vermelha, [Est. Rio de Jan.], Brazil, in the British Museum, examined.

Theridion quemadum Levi, 1959, Bull. Mus. Comp. Zool., 121: 140, figs. 257-258, ♀. Female holotype from Chiapas, Mexico, in the American Museum of Natural History. NEW SYNONYMY.

Figures 131-134 were prepared from the syntypes.

Distribution. Mexico to southeastern Brazil (Map 2).

Records. Venezuela. Dist. Fed.: Caracas, 1887-1888 (E. Simon, MNHN); hacienda Corosal, N of Mt. Silla, 1888 (E. Simon, MNHN). *Aragua:* Gulfo Triste (W. Beebe, AMNH). *Brazil. Guanabara:* Leblon (H. Sick, AMNH).

Theridion schrammeli sp. n.

Figures 135-136

Holotype. Male from Tamazunchale, San Luis Potosí, Mexico, 20 May 1952 (W. J. Gertsch, M. Cazier, R. Schrammel), in the American Museum of Natural History. The species is named after Mr. R. Schrammel, its collector.

Description. Carapace, sternum, legs yellow-white. Abdomen yellow-white with two pigment lines, fused in front and behind, continuing for a short distance as a single line to the spinnerets. Some scattered, small white spots on sides and also some gray spots. Venter of abdomen yellow-white. Eyes subequal in size. Anterior median eyes one diameter apart, almost touching laterals. Posterior eyes a little less than their diameter apart. Total length 1.5 mm. Carapace 0.71 mm long, 0.67 mm wide. Fourth femur, 0.91 mm; patella and tibia, 0.86 mm; metatarsus, 0.62 mm; tarsus, 0.29 mm.

Diagnosis. The palpus having the median apophysis with a long proximal prong (Figs. 135, 136) separates it from other species of the *T. frondeum* group.

Theridion costaricaense sp. n.

Figures 137-138

Holotype. Female from Summit, Panama Canal Zone, 16-17 Aug. 1950 (A. M. Chickering), in the Museum of Comparative Zoology. The specific name is an adjective of Costa Rica.

Description. Carapace, sternum, legs yellow-white. Abdomen yellow-white, except for two parallel rows of about five white spots on dorsum. Eyes small but subequal in size. Anterior median eyes one and one-half diameters apart, one diameter from laterals. Posterior median eyes two diameters apart, one and one-half diameters from laterals. Abdomen bulging and slightly elevated and projecting behind spinnerets but not as much as in members of the genus *Chrysso.* Total length 2.7 mm. Carapace 0.9 mm long, 0.7 mm wide. First femur, 3.1 mm; patella and tibia, 3.0 mm; metatarsus, 2.9 mm; tarsus, 0.9 mm. Second patella and tibia, 1.6 mm; third, 0.9 mm; fourth, 1.6 mm. The right lung of the type specimen is infected with an arthropod parasite.

Diagnosis. The large epigynum depression and short ducts (Figs. 137-138) and the shape of the abdomen separate this species from *T. barroanum.*

Records. Costa Rica: Siquirres, 20-23 May 1944, ♀ paratype (F. Schrader, AMNH). *Venezuela. Carabobo:* San Esteban, 1888, ♀ (E. Simon, MNHN).

Theridion barroanum Levi

Theridion barroanum Levi, 1959, Bull. Mus. Comp. Zool., 121: 122, figs. 234-235, ♀. Female holotype from Panama Canal Zone in the Museum of Comparative Zoology.

Additional record. Ecuador. El Oro: Río Jubanes, Pasaje, 23 Oct. 1942 (R. Walls).

Theridion hassleri sp. n.

Figures 139-140

Holotype. Female from Valle de Polo, 600-1000 m elev., Dominican Republic, Aug. 1935 (H. B. Hassler), in the American Museum of Natural History. The species is named after the collector.

Description. Carapace yellow-white with a gray median band which stops in cephalic region but continues as three diverging lines towards eyes. Sternum yellow-white. Legs yellow-white with black spots on venter. Abdomen yellow-white, dorsum with white pigment and some gray. Eyes very large and subequal. Anterior median eyes two-thirds diameter apart, touching laterals. Posterior eyes their radius apart. Abdomen wider than long, subtriangular. Total length 1.9 mm. Carapace 0.91 mm long, 0.77 mm wide. First femur, 1.55 mm; patella and tibia, 1.62 mm; metatarsus, 1.17 mm; tarsus, 0.60 mm. Second patella and tibia, 1.30 mm; third, 0.74 mm; fourth, 0.92 mm.

Diagnosis. The anterior border of the epigynum depression and the shorter ducts (Figs. 139-140) separate this species from *T. barroanum* Levi.

Record. ♀ paratype collected with holotype.

Theridion rampum sp. n.

Figures 141-142, 232-233

Holotype. Male from Monzón, Tingo María, Huánuco, Peru, 10 Oct. 1954 (E. I. Schlinger, E. S. Ross), in the California Academy of Sciences. The specific name is an arbitrary combination of letters.

Description. Carapace, sternum, legs yellow. Abdomen black with a white median stripe which is widest in middle and whose

margins are emarginate. Venter whitish. Eyes subequal in size. Anterior median eyes one diameter apart, almost touching laterals. Posterior eyes three-quarters their diameter apart. Chelicerae with one tooth on anterior margin. Total length of female from Venezuela 2.4 mm. Carapace 0.8 mm long, 0.8 mm wide. First femur, 1.5 mm; patella and tibia, 1.5 mm; metatarsus, 0.9 mm; tarsus, 0.7 mm. Second patella and tibia 1.0 mm; third, 0.7 mm; fourth, 1.1 mm. Total length of male 1.8 mm. Carapace 0.85 mm long, 0.76 mm wide. First femur, 1.17 mm; patella and tibia, 1.32 mm; metatarsus, 1.01 mm; tarsus, 0.53 mm. Second patella and tibia, 1.04 mm; third, 0.74 mm; fourth, 1.0 mm.

Diagnosis. The course of the duct in the palpus (Figs. 232, 233) separates this species from *T. panamense* Levi and *T. marvum* Levi. The epigynum (Fig. 142) has a subcircular depression. The dark connecting ducts show through the surface posterior to the depression.

Records. Venezuela. Carabobo: San Esteban, March 1888, ♀ ♂ (E. Simon, MNHN).

Theridion marvum Levi

Theridion marvum Levi, 1959, Bull. Mus. Comp. Zool., 121: 128, fig. 326, ♂. Male holotype from Panama Canal Zone, in the Museum of Comparative Zoology.

Record. Venezuela. Carabobo: San Esteban, 1888 (E. Simon, MNHN).

Theridion artum Levi

Theridion artum Levi, 1959, Bull. Mus. Comp. Zool., 121: 124, figs. 313-314, ♀. Female holotype from Panama Canal Zone, in the Museum of Comparative Zoology.

This species was known from the holotype only. The connecting ducts of the Trinidad specimen have a smaller diameter than those of the holotype.

Additional record. Lesser Antilles. Trinidad: Simla near Arima, Feb. 1959, ♀ (A. M. Nadler, AMNH), doubtful determination.

Theridion petrum Levi

Theridion petrum Levi, 1959, Bull. Mus. Comp. Zool., 121: 127, figs. 280-284, ♀, ♂. Male holotype from Panama Canal Zone, in the Museum of Comparative Zoology.

Distribution. Panama, Trinidad, Peru.

Additional records. Peru. Huánuco: Divisoria, 1700 m elev. (F. Woytkowski).

Theridion tempum Levi

Map 3

Theridion tempum Levi, 1959, Bull. Mus. Comp. Zool., 121: 137, figs. 315-316, ♀. Female holotype from Panama in the Museum of Comparative Zoology.

Note. The specimen from Brazil differs in coloration from the Panamanian type. The carapace is yellowish with a darker median, longitudinal stripe. The sternum is yellow with a black spot on each side. The dorsum of the abdomen has two wide longitudinal bands which fuse above the spinnerets. On each side of the bands are black patches. The venter has a narrow black transverse band which reaches up to the black spots on each side.

Records. Brazil. Pará: Belém, ♀ (M. de Mathan, MNHN).

Theridion armouri Levi

Figures 143-144

Theridion armouri Levi, 1959, Bull. Mus. Comp. Zool., 121: 138, figs. 259-260, ♀. Female holotype from Panama Canal Zone, in the Museum of Comparative Zoology.

This species was heretofore known only from the holotype specimen.

Additional record. Lesser Antilles. Trinidad: Simla near Arima, Feb. 1959, ♀ (A. M. Nadler, AMNH).

Theridion monzonense sp. n.

Figures 145-146

Holotype. Female from Monzón Valley, Tingo María, Huánuco, Peru, 2 Dec. 1954 (E. I. Schlinger, E. S. Ross), in the California Academy of Sciences. The species is named after the type locality.

Description. Carapace, sternum, legs yellow. Abdomen yellowish white with some small white pigment spots grouped in irregular patches on each side and in a line above spinnerets on dorsum; venter without marks. Anterior median eyes slightly larger than others, two-thirds their diameter apart, one-quarter their diameter from laterals. Posterior median eyes one diameter apart, a

little more than their diameter from laterals. Chelicerae with one long tooth on anterior margin. Total length 2.2 mm. Carapace 0.81 mm long, 0.73 mm wide. First femur, 1.12 mm; patella and tibia, 1.16 mm; metatarsus, 0.55 mm; tarsus, 0.50 mm. Second patella and tibia, 0.83 mm; third, 0.65 mm.

Diagnosis. The epigynum has a depression with an anterior lip with the opening on each side (Fig. 146). It differs from *T. atropunctatum* by having larger tarsi, larger anterior median eyes, and relatively larger epigynum.

Theridion teresae sp. n.

Figures 147-148

Holotype. Female from Santa Teresa, Espírito Santo, Brazil, 26 Jan. 1959 (A. M. Nadler), in the American Museum of Natural History. This species is named after the type locality.

Description. Carapace light brown, darker anterior. Sternum black. Legs brown with a black dorsal longitudinal line extending the full length of the first and second femora. Anterior of abdomen above pedicel black. Dorsum with small white pigment spots and scattered very small gray pigment spots. Venter without pigment. Posterior median eyes larger than other eyes. Anterior medians about subequal to laterals. Anterior median eyes three-quarters their diameter apart, less than one-third from laterals. Posterior median eyes one-third diameter apart, less than their radius from laterals. The abdomen of this species is wider than long. Total length 2.0 mm. Carapace 0.78 mm long, 0.76 mm wide. First femur, 1.50 mm; patella and tibia, 1.52 mm; metatarsus, 0.78 mm; tarsus, 0.40 mm. Second patella and tibia, 1.22 mm; third, 0.64 mm; fourth, 1.00 mm.

Diagnosis. The coiled duct (Fig. 147) separates *T. teresae* from *T. donatum* Banks. The black stripes on the femora separate it also from this and other species having the abdomen wider than long.

Theridion parvum Keyserling

Figures 149-150

Theridium parvum Keyserling, 1884, Die Spinnen Amerikas, Theridiidae, 2(1): 83, pl. 4, fig. 52, ♀. Female holotype from Tambillo, [1800 m elev., Piura, prov. Jean], Peru, in the Polish Academy of Sciences, Warsaw, examined.

This species may be the female of *T. fungosum* Keyserling.

The abdomen is wider than long and has three white spots on dusky background. Anterior median eyes three-quarters diameter apart, their radius from laterals. Posterior eyes three-quarters diameter apart. One blunt tooth on pro-margin of chelicerae. Total length 1.8 mm. Carapace 0.72 mm long. First patella and tibia, 1.70 mm; second, 1.40 mm; third, 0.88 mm; fourth, 1.05 mm.

The figures were prepared from the holotype.

Theridion fungosum Keyserling

Figure 179

Theridium mirabile Keyserling, 1884, Die Spinnen Amerikas, Theridiidae, 2(1): 39, pl. 2, fig. 20, ♂. Male type from Paltaypampa, [Junín, ? prov. Tarma] Peru, in the Polish Academy of Science, Warsaw, examined. Name preoccupied by *Theridion mirabile* Holmberg, 1872.

Theridium fungosum Keyserling, 1886, *op. cit.*, 2(2): 294. New name for *T. mirabile* Keyserling, preoccupied.

Theridion guriae Strand, 1917, Arch. Naturgesch., 82(2): 72. New name for *T. mirabile* Keyserling, preoccupied.

Note. Bonnet (1959, Bibliographia Araneorum, 2: 4478) erroneously called this species *T. guriae,* overlooking the fact that Keyserling had already given it a new name.

This species is close to *T. pallisterorum* Levi and *T. dotanum* (Banks); however, the embolus tip differs. *T. parvum* Keyserling may be the female of this species.

Figure 179 was prepared from the holotype of *T. mirabile.*

Record. Ecuador. Chimborazo: 48 km SW of Alausí, 14 Feb. 1955, ♂ (E. I. Sehlinger, E. S. Ross, CAS), doubtful determination.

Theridion bellatulum sp. n.

Figures 151-153

Holotype. Female from Teresópolis, Est. Rio de Janeiro, 900-1000 m elev., Brazil (H. Sick), in the American Museum of Natural History. The specific name is an arbitrary combination of letters.

Description. Carapace, sternum orange. Legs yellowish with darker spots; proximal portion of femora and coxae light. Dorsum of abdomen with a white line enclosing a red lanceolate mark (Fig. 153), black behind and a white line on each side. Venter deep black with a large white spot between epigynum and spinnerets. Eyes subequal in size. Anterior median eyes one

diameter apart, one-third diameter from laterals. Posterior median eyes three-quarters diameter apart, one diameter from laterals. Total length 2.4 mm. Carapace 0.98 mm long, 0.91 mm wide. First femur, 1.30 mm; patella and tibia, 1.43 mm; metatarsus, 0.91 mm; tarsus, 0.52 mm. Second patella and tibia, 1.15 mm; third, 0.84 mm; fourth, 1.23 mm.

Diagnosis. The epigynum has a squarish opening with a dark rim (Fig. 152). The internal genitalia (Fig. 151) separate it from *T. volubile*.

Theridion decoloratum Keyserling

Figures 154-155

Theridium decoloratum Keyserling, 1886, Die Spinnen Amerikas, Theridiidae, 2(2): 234, pl. 20, fig. 289, ♀. Female holotype from Blumenau, [Santa Catarina, Brazil], in the British Museum, examined.

This species may not be a *Theridion*, or it may belong to the group of *T. jamaicense* Levi, *T. antillanum* Simon, and *T. biezankoi* which lacks pigmentation in alcohol, but may have been green when alive.

Theridion pires sp. n.

Figures 156-157

Holotype. Female from Ribeirão Pires, Est. São Paulo, 700-800 m elev., Brazil, Dec. 1945 (H. Sick), in the American Museum of Natural History. The specific name is a noun in apposition after the type locality.

Description. Carapace brown, dark gray on sides and head. Sternum gray. Legs yellow with fine black spots on undersides. Abdomen with a wide white band in irregular outline, slightly dark on sides; white and black marks going at right angles down sides. Venter black with a large white spot between spinnerets and epigynum. Eyes subequal in size. Anterior median eyes three-quarters their diameter apart, almost touching laterals. Posterior median eyes one-third diameter apart, their radius from laterals. Total length 2.00 mm. Carapace 0.78 mm long. Third patella and tibia, 0.65 mm.

Diagnosis. The internal genitalia (Fig. 156) separate this species from *T. volubile*, and the posterior lip separates this species from *T. cowlesae* Levi, found in the United States.

Theridion tungurahua sp. n.

Figures 158-160; Map 3

Holotype. Female from Baños, Tungurahua Province, Ecuador, 15-21 June, 1943 (H. E. and D. L. Frizzell), in the Museum of Comparative Zoology. The specific name is a noun in apposition after the type locality.

Description. Carapace yellow with black narrow margin and a narrow black line in middle. Sternum black. Legs yellow with black spots underneath. Abdomen wider than long, white with several black patches; on each side of epigynum a black loop. Anterior median eyes slightly smaller than others, one diameter apart, almost touching laterals. Posterior median eyes one-third diameter apart, their radius from laterals. Total length 2.3 mm. Carapace 0.91 mm long, 0.86 mm wide. First femur, 1.58 mm; patella and tibia, 1.56 mm; metatarsus, 1.04 mm; tarsus, 0.53 mm. Second patella and tibia, 1.23 mm; third, 0.78 mm; fourth, 0.99 mm.

Diagnosis. The circular depression of the epigynum (Fig. 160) and the internal genitalia which seem quite variable (Figs. 158, 159) separate this species from the closely related *T. sexmaculatum* Keyserling; the narrower ducts from *T. fastosum.*

Record. Venezuela. Aragua: Tovar, 1888, ♀ (E. Simon, MNHN). *Brazil. Guanabara:* near Rio de Janeiro (Germain, MNHN). *São Paulo:* Botanical Gardens, São Paulo, Jan. 1959 (A. M. Nadler, AMNH).

Theridion atropunctatum Petrunkevitch

Figures 161-165; Map 2

Theridion atropunctatum Petrunkevitch, 1930, Trans. Connecticut Acad. Sci., 30: 210, figs. 59, 60, ♀. Female holotype from Arecibo, Puerto Rico, probably lost. — Levi, 1957, Bull. Amer. Mus. Nat. Hist., 112: 66, figs. 225-228, 232-234, ♀, ♂, map 21; 1959, Bull. Mus. Comp. Zool., 121: 112.

Note. It is not at all certain if the specimens from southern Brazil (Figs. 161-165) are this species. The palpal radix is partially hidden behind the embolus and the conductor is curved along the embolus (Figs. 161, 162). The drawings were made from São Paulo, Brazil, specimens.

Distribution. Southern Florida, Central America, West Indies, Venezuela, probably to southern Brazil (Map 2).

Additional records. Trinidad. Simla near Arima, 26 Feb.

1959, ♀ (A. M. Nadler, AMNH). *Venezuela. Dist. Fed.:* Caracas, 1887-1888 (E. Simon, MNHN). *Ecuador. El Oro:* Buenavista, 20 km SE of Machala, Nov. 1942 (E. L. Moore). *Brazil. Est. São Paulo:* São Paulo, Forest Reservation, 16 Jan. 1959, ♀ ♂ (A. M. Nadler, AMNH); São Paulo, Botanical Gardens, 13-17 Jan. 1959, ♀ ♂ (A. M. Nadler, AMNH).

Theridion crispulum Simon

Figures 166-172; Map 2

Theridion crispulum Simon, 1895, Ann. Soc. ent. France, 64: 142. Female holotype from La Guaira, [Dist. Fed.], Venezuela, in the Muséum National d'Histoire Naturelle, Paris, examined. — Levi, 1959, Bull. Mus. Comp. Zool., 121: 113.

Theridion intervallatum Emerton, 1915, Trans. Connecticut Acad. Sci., 20: 136, pl. 1, fig. 1, ♂. Male holotype from Intervale, New Hampshire, United States, in the Museum of Comparative Zoology. — Levi, 1957, Bull. Amer. Mus. Nat. Hist., 112: 64, figs. 222-224, 229-231, ♀, ♂, map 21.

Note: There seems to be considerable variation in the epigynum and position of the female ducts (Figs. 168, 170, 171). The illustrations (Figs. 166-172) were made from specimens from São Paulo, Brazil.

Distribution. Eastern North America from Nova Scotia to southern Brazil (Map 2).

Additional records. Trinidad. Piarco (A. M. Nadler, AMNH). *Venezuela. Carabobo:* San Esteban (E. Simon, MNHN). *Surinam.* Paramaibo (A. M. Nadler, AMNH). *Ecuador. Guayas:* Guayaquil (M. E. Hubbard). *El Oro:* Río Jubanes, Pasaje, Oct. (R. Walls). *Brazil. Pernambuco:* Recife (A. M. Nadler, AMNH). *Bahia:* Salvador (A. M. Nadler, AMNH). *Minas Gerais:* Caraça (E. Gounelle, MNHN). *Espírito Santo:* Santa Teresa (A. M. Nadler, AMNH). *Guanabara:* Rio de Janeiro (A. M. Nadler, AMNH). *Est. São Paulo:* São Paulo (A. M. Nadler, AMNH). *Santa Catarina:* Nova Teutonia, lat 27°11′S, long 52°23′W (F. Plaumann, SMF).

Theridion minutissimum Keyserling

Figures 173-176

Theridium minutissimum Keyserling, 1884, Die Spinnen Amerikas, Theridiidae, 2(1): 34, pl. 2, fig. 17, ♀, ♂. Male lectotype designated by Levi, 1959, from Montaña di Nancho 2600 m elev., [? Cajamarca], Peru, in the Polish Academy of Sciences, Warsaw, examined. — Levi, 1959, Bull. Mus. Comp. Zool., 121: 121, fig. 249, ♂.

The illustrations were made from the syntypes.
Record. Panama. (Levi, 1959).

Theridion positivum Chamberlin

Figures 177-178; Map 2

Theridion positivum Chamberlin, 1924, Proc. California Acad. Sci., (4)12: 636. Female holotype from Pond Island, Gulf of California, in the California Academy of Sciences. — Levi, 1957, Bull. Amer. Mus. Nat. Hist., 112: 68, figs. 237-239, 243-246, ♀, ♂, map 22.

Theridion denisi Caporiacco, 1955, Acta Biol. Venezuelica, 1: 332, fig. 24, ♀. Female type from Rancho Grande, Aragua, Venezuela in the Museo de Biología, Universidad Central, Caracas, examined. NEW SYNONYMY.

Distribution. Southern California, southern Texas, Mexico, Central America, West Indies, Venezuela, northwestern Peru to southern Brazil (Map 2).

Additional records. Haiti: Damiens, Port-au-Prince (A. M. Nadler, AMNH). *Venezuela Dist. Fed.:* Caracas, 1887-1888 (E. Simon, MNHN). *British Guiana.* Georgetown, Feb. 1959 (A. M. Nadler, AMNH). *Ecuador. El Oro:* Arenillas, Oct. 1942 (R. Walls). *Peru. Piura:* Valle Pariñas, April 1939 (H. E., D. L. Frizzell). *Brazil. Pará:* Belém, Feb. 1959, ♀ (A. M. Nadler, AMNH), doubtful det. *Espírito Santo:* Santa Teresa, Jan. 1959, ♀ (A. M. Nadler, AMNH). *São Paulo:* São Paulo, Jan. 1959 (A. M. Nadler, AMNH). *Santa Catarina:* Nova Teutonia, lat 27°11′S, long 52°23′W, ♂ (F. Plaumann, SMF). *Paraguay.* ♀ (Germain, MNHN).

Theridion maron sp. n.

Figures 180-181

Holotype. Female from "S. Louis" [? S. Luis de la Sierra], Paraguay, Oct. 1908, in the American Museum of Natural History. The specific name is an arbitrary combination of letters.

Description. The whole spider yellow-white except for dorsum of abdomen which has some fine scattered white pigment spots and a median dorsal white band having a wavy outline. Eyes subequal in size. Anterior median eyes one diameter apart, almost touching laterals. Posterior eyes a little less than their diameter apart. The abdomen is slightly wider than long. Total length 2.7 mm. Carapace 0.83 mm long, 0.72 mm wide. First femur, 1.50 mm. Second patella and tibia, 0.96 mm; third, 0.68 mm.

Diagnosis. This species which belongs to the *T. murarium* group has internal genitalia (Fig. 180) which are similar to *T. australe* Banks and *T. goodnightorum* Levi. However, it lacks the black coloration of these North American species.

Natural History. Theridion maron has been found on shrubs.

Theridion querulum Keyserling

Figures 182-183

Theridium querulum Keyserling, 1891, Die Spinnen Amerikas, Brasilianische Spinnen, 3: 186, pl. 6, fig. 131, ♀. Female holotype from Rio Grande do Sul, Brazil, in the British Museum, examined.

Theridion rubrum (Keyserling), new combination

Figures 184-185

Steatoda rubra Keyserling, 1886, Die Spinnen Amerikas, Theridiidae, 2(2): 239, pl. 20, fig. 294, ♀. Female holotype from Blumenau, [Santa Catarina], Brazil, in the British Museum, examined.

Theridion schlingeri sp. n.

Figures 186-187

Holotype. Female from Monzón Valley, near Tingo María, Huánuco, Peru, 10 Oct. 1954 (E. I. Schlinger, E. S. Ross), in the California Academy of Sciences. The species is named after Dr. E. I. Schlinger, its collector.

Description. Carapace, sternum, legs yellowish white. Abdomen yellowish white with irregular white pigment spots on dorsum. Anterior median eyes slightly smaller than others, one and one-half diameters apart, more than their diameter from laterals. Posterior median eyes one diameter apart, more than a diameter from laterals. Total length 2.9 mm. Carapace 1.0 mm long, 0.8 mm wide. First femur, 2.4 mm; patella and tibia, 2.3 mm; metatarsus, 2.3 mm; tarsus, 0.7 mm. Second patella and tibia, 1.3 mm; third, 0.8 mm; fourth, 1.4 mm.

Diagnosis. The epigynum whose openings are on the posterior margin and facing posteriorly (Figure 187) separates this species from other *Theridion*. No species close to *T. schlingeri* are known.

Theridion machu sp. n.

Figures 188-189

Holotype. Female from Machu Picchu, Cuzco, 2100 m elev., Peru, 20-21 March 1947 (J. C. Pallister), in the American Mu-

seum of Natural History. The specific name is a noun in apposition after the type locality.

Description. The spider is yellowish white, almost without pigment except for the dorsum of the abdomen which is covered solid with white pigment. Eyes very small. Anterior median eyes smaller than others, two and one-quarter diameters apart, a little more than one diameter from laterals. Posterior eyes one and one-half diameters apart. Total length 2.7 mm. Carapace 1.1 mm long, 0.9 mm wide. First femur, 2.7 mm; patella and tibia, 2.6 mm; metatarsus, 2.8 mm; tarsus, 0.9 mm. Second patella and tibia, 1.5 mm; third, 0.9 mm; fourth 1.6 mm.

Diagnosis. The epigynum has an indistinct oval depression with a darker spot on each side. The long coiled connecting duct (Fig. 188) readily separates this species from other *Theridion.*

Theridion senckenbergi sp. n.

Figures 190-191

Holotype. Female from Maracay, Aragua, Venezuela, in the Senckenberg Museum (no. RII/9162/1). The species is named after Dr. J. C. Senckenberg, 18th century physician and naturalist.

Description. Carapace, sternum, legs whitish. Legs with narrow black rings around distal ends of first tibiae and tarsi. Abdomen whitish with large white pigment areas on dorsum. Anterior median eyes smaller than others, one and one-half diameters apart, one diameter from laterals. Posterior eyes one and one-half diameters apart. Chelicerae with two teeth on anterior margin. Total length 3.1 mm. Carapace 1.1 mm long, 0.9 mm wide. First femur, 2.3 mm; patella and tibia, 2.5 mm; metatarsus, 2.0 mm; tarsus, 0.8 mm. Second patella and tibia, 1.4 mm; third, 0.9 mm; fourth, 1.5 mm.

Diagnosis. The looping ducts of the epigynum (Fig. 190) separate this species from others belonging to the *T. frondeum* group, especially the related *T. incertissimum.*

Theridion incertissimum (Caporiacco), new combination

Figures 192-193

Tidarren incertissimum Caporiacco, 1954, Comm. Pontifica Acad. Sci., 16: 77. Female holotype from St. Jean du Maroni, French Guiana, in the Muséum National d'Histoire Naturelle, Paris, examined.

Description. The coloration is yellow-white. The abdomen has white and gray stripes down each side. The total size is 3.7 mm. The opening of the epigynum (Fig. 193) is indistinct. The epigynum is lightly transparent and some of the ducts are visible. It may belong to the genus *Achaearanea.*

Record. Brazil. Amazonas: (or Loreto, Peru) "Pebas, São Paulo de Olivença" 3 ♀ (MNHN).

Theridion adamsoni Berland

Map 1

Theridion adamsoni Berland, 1934, Bull. B. P. Bishop Mus., no. 113: 102, figs. 6-9, ♀. Female syntypes from Tahiti in the B. P. Bishop Museum, Honolulu, examined.

Theridion hobbsi Gertsch and Archer, 1942, Amer. Mus. Novitates, no. 1171: 5, fig. 6, ♀. Female holotype from Florida, in the American Museum of Natural History. — Levi, 1957, Bull. Amer. Mus. Nat. Hist., 112: 62, figs. 198-199, 209, 213-214, ♀, ♂, map 28.

Distribution. Cosmotropical; Gulf coast states, West Indies, Panama to Brazil (Map 1).

Additional records. Cuba. Oriente: Baños (A. Archer). *Puerto Rico:* Villa Uro. *Brazil.* Pará: Belém (A. M. Nadler, AMNH). *Bahia:* Salvador (A. M. Nadler, AMNH). *Ceará:* Fortaleza (A. M. Nadler, AMNH). *Guanabara:* Rio de Janeiro (A. M. Nadler); Tijuca (E. Gounelle, MNHN).

Ghana. Accra, Achimota, June, July, 1961 (C. P. Hinckley), on and in house.

Theridion apostoli Mello-Leitão

Figures 196-197

Theridion apostoli Mello-Leitão, 1945, Rev. Mus. La Plata, n. s., 4: 234, fig. 8, ♀. Female holotype from Mburucuyá, Corrientes, Argentina, in the Museo de la Plata, examined.

The epigynum and general appearance of this small species resembles *T. adamsoni* Berland. The epigynum (Fig. 197), having a septum at the anterior of the depression, readily separates it from *T. adamsoni.*

Theridion ampascachi Mello-Leitão

Figures 198-199

Theridion ampascachi Mello-Leitão, 1941, Rev. Mus. la Plata, n. s., 2: 144, fig. 40, ♀. Female holotype from Ampascachi, Salta, Argentina, in the Museo de la Plata, examined.

The genitalia (Figs. 198-199) readily distinguish this light-colored species from other *Theridion*.

Theridion dominica sp. n.

Figures 200-201

Holotype. Female from Roseau, Dominica, Lesser Antilles, in the American Museum of Natural History. The specific name is a noun in apposition after the type locality.

Description. Carapace, sternum, legs yellow-white. Abdomen yellow-white with white pigment on dorsum, and a gray patch anterior to spinnerets on venter. Anterior median eyes slightly smaller than others, two diameters apart, one diameter from laterals. Posterior eyes one diameter apart. Chelicerae with two teeth on anterior margin. Total length 3.8 mm. Carapace 1.6 mm long, 1.2 mm wide. First femur, 5.5 mm; patella and tibia, 5.4 mm; metatarsus, 6.0 mm; tarsus, 1.4 mm. Second patella and tibia, 2.9 mm; third, 1.4 mm; fourth, 3.3 mm.

Diagnosis. The genitalia separate this species from others of the *T. frondeum* group. The epigynum (Fig. 201) has two openings towards the anterior of a lightly sclerotized plate.

Theridion torosum Keyserling

Figures 202-203

Theridium torosum Keyserling, 1884, Die Spinnen Amerikas, Theridiidae, 2(1): 36, pl. 2, fig. 18, ♀, ♂. Female holotype from Montaña di Nancho, 2500 m elev., [? Cajamarca], Peru, in the Polish Academy of Sciences, examined.

This large species has an epigynum with a shallow depression containing at its anterior end a dark round spot (Fig. 203). There is a pair of dark spots, the ducts, behind. Behind the depression is a groove. Figures 202-203 were made from the holotype.

Theridion macuchi sp. n.

Figures 204-205

Holotype. Female from Macuchi, copper mining camp, probably in Los Ríos Prov., some distance from Río Palenque, Ecuador, March 1943 (H. E. Frizzell), in the Museum of Comparative Zoology. The specific name is a noun in apposition after the type locality.

Description. Carapace uneven brown. Sternum brown. Legs brown with darker spots on venter. Abdomen dark gray with a pair of white pigment spots on back and a few small spots on sides. Anterior median eyes slightly smaller than others, their diameter apart, one-quarter their diameter from laterals. Posterior eyes one diameter apart. Total length 2.5 mm. Carapace 1.04 mm long, 0.95 mm wide. First femur, 1.50 mm; patella and tibia, 1.56 mm; metatarsus, 1.08 mm; tarsus, 0.62 mm. Second patella and tibia, 1.08 mm; third, 0.78 mm; fourth, 1.30 mm.

Diagnosis. The internal female genitalia separate this species from *T. morulum* O. P.-Cambridge. The epigynum (Fig. 205) is quite similar; it has a very dark shiny knob at the posterior edge. The openings are believed to be slightly separated on the tip of the knob.

Theridion maranum sp. n.

Figure 206

Holotype. Male from Tovar, Aragua, Venezuela, 1888 (E. Simon), in the Muséum National d'Histoire Naturelle, Paris (no. 11631). The specific name is an arbitrary combination of letters.

Description. Carapace yellow, darker on sides, a small black spot near posterior border. Sternum light yellow. Legs yellow-white. Abdomen white with seven gray symmetrically arranged round spots on dorsum. Carapace quite long, low and selerotized. Eyes appearing small. Anterior median eyes slightly smaller than others, one and one-half their diameter apart, one and one-quarter their diameter from laterals. Posterior eyes one and one-half their diameter apart. Total length 2.0 mm. Carapace 1.09 mm long, 0.81 mm wide. First femur, 1.20 mm; patella and tibia, 1.36 mm; metatarsus, 0.96 mm; tarsus, 0.41 mm. Second patella and tibia, 0.91 mm; third, 0.57 mm; fourth, 0.91 mm.

Diagnosis. This species is close to *T. rufipunctum;* most likely the abdomen of the female is wider than long. The palpus (Fig. 206) has a shorter tibia, larger, more selerotized median apophysis and heavier embolus.

Theridion umbilicus sp. n.

Figures 207-208

Holotype. Male from Caraça, Minas Gerais, Brazil (E. Gounelle), in the Muséum National d'Histoire Naturelle, Paris (no. 8884). The specific name is a noun meaning navel.

Description. Carapace, sternum orange. Legs yellowish, distal segments darker to brown. Abdomen with a median dorsal longitudinal light band, narrow anterior and posterior, containing some white pigment spots which are dense above spinnerets. The band is bordered by black. Sides of dorsum light. Venter of abdomen black with black tongues going up sides and a white spot between genital area and spinnerets. Anterior median eyes slightly larger than others, their diameter apart, one-third their diameter from laterals. Posterior median eyes a little more than one diameter apart, one and one-half diameters from laterals. Posterior median eyes slightly triangular in shape. Chelicerae with one tooth on anterior margin. Total length 2.2 mm. Carapace 1.0 mm long, 0.9 mm wide. First femur, 1.4 mm; patella and tibia, 1.3 mm; metatarsus, 1.1 mm; tarsus, 0.6 mm. Second patella and tibia, 1.1 mm; third, 0.8 mm; fourth, 1.0 mm.

Diagnosis. This species is separated from others by the button-like mark on the tegulum of the palpus (Fig. 207). The embolus lies underneath a lobe of the tegulum and can only be seen in the cleared palpus (Fig. 208). Otherwise the species looks similar to *Achacaranea quadripartitum.*

Theridion aulos sp. n.

Figure 209

Holotype. Male from Jabaquara, 700-800 m elev., Cidade São Paulo, Brazil, 21 Dec. 1945 (H. Sick), in the American Museum of Natural History. The specific name is an arbitrary combination of letters.

Description. Carapace, sternum, legs yellowish. Head region black. Abdomen white. Eyes subequal in size. Anterior median eyes one and one-half diameters apart, three-quarters from laterals. Posterior median eyes one diameter apart, one and one-quarter diameters from laterals. Abdomen very soft, almost shapeless in alcohol. Total length 1.7 mm. Carapace 0.71 mm long, 0.66 mm wide. First femur, 1.36 mm; patella and tibia, 1.10 mm; metatarsus, 0.75 mm; tarsus, 0.45 mm. Second patella and tibia, 0.88 mm; third, 0.68 mm; fourth, 0.85 mm.

Diagnosis. Unlike other species of *Theridion* known, the tegulum is very heavily sclerotized (Fig. 209).

Record. One ♂ paratype collected with holotype.

Theridion nesticum sp. n.

Figure 210

Holotype. Male from Simla near Arima, Trinidad, Lesser Antilles, 26 Feb. 1959 (A. M. Nadler), in the American Museum of Natural History. The specific name is an arbitrary combination of letters.

Description. Carapace light brown. Sternum light grayish brown. Legs very light brown. Dorsum of abdomen with white pigment spots in an anterior and a posterior transverse band; some black pigment posterior on sides. Carapace almost circular in outline. Lateral eyes noticeably smaller than other eyes. Posterior median eyes largest. Anterior median eyes two-thirds their diameter apart, touching laterals. Posterior median eyes one-third diameter apart, their radius from laterals. Chelicerae with two teeth on the anterior margin, the outside tooth being larger, and one tooth on the inside margin. The anterior end of the subtriangular abdomen has two sclerotized ridges above the pedicel. Total length 1.9 mm. Carapace 0.77 mm long, 0.77 mm wide. First femur, 1.88 mm; patella and tibia, 1.82 mm; metatarsus, 1.28 mm; tarsus, 0.50 mm. Second patella and tibia, 1.53 mm; third, 0.75 mm; fourth, 1.11 mm.

Diagnosis. The relationship of this species to others is quite uncertain. It is believed that the abdomen of the female is wider than long. The palpus (Fig. 210) resembles that of species belonging to *Anelosimus*. It lacks a colulus; however, it has a tooth on the posterior margin of the chelicerae, an unusual feature in *Theridion*. It may be close to *T. adamsoni;* the base of the embolus separates the two species.

Theridion altum sp. n.

Figures 211-212

Holotype. Female from Taguararapa, Alto-Paraná, Paraguay, in the American Museum of Natural History. The specific name is an arbitrary combination of letters.

Description. Carapace, sternum yellow-white. Legs yellow-white with narrow black rings and distal portions of femora black. Abdomen yellow-white with a median white band, on the side of which are small white and black spots; venter yellow-white. Eyes subequal in size. Anterior median eyes their diameter apart, almost touching laterals. Posterior median eyes their radius apart, three-quarters diameter from laterals. Total

length 2.2 mm. Carapace 0.83 mm long, 0.75 mm wide. First femur, 1.38 mm; patella and tibia, 1.40 mm; metatarsus, 1.09 mm; tarsus, 0.48 mm. Second patella and tibia, 0.98 mm; third, 0.65 mm; fourth, 1.01 mm.

Diagnosis. The epigynum (Fig. 212) is a slight orange swelling with an indistinct slit. The long connecting ducts show through the anterior portion of the swelling and are similar to those of *T. antillanum* Simon. *Theridion altum* differs from *T. antillanum* by having oval seminal receptacles and lacking the posterior lip on the epigynum. The species may also be close to the larger *T. biezankoi* known only from a male.

Theridion biezankoi sp. n.

Figure 213

Holotype. Male from Pelotas, Est. Rio Grande do Sul, Brazil, Oct. 1954 (C. Biezanko), in the American Museum of Natural History. The species is named after Prof. C. M. Biezanko, its collector.

Description. The spider is whitish without pigment in alcohol, except for pigment in eyes. The eyes seem far apart and small. Eyes subequal in size. Anterior median eyes two diameters apart, a little more than one diameter from laterals. Posterior median eyes two diameters apart, one and one-half diameters from laterals. Abdomen almost spherical. Total length 3.5 mm. Carapace 1.6 mm long, 1.4 mm wide. Second patella and tibia, 2.0 mm; third, 1.2 mm; fourth, 2.4 mm.

Diagnosis. This species, which is close to *T. antillanum*, has a longer embolus and a more elaborate palpus (Fig. 213). It is not known with certainty that the supporting structure of the embolus is the radix. The shape of the cymbium resembles that in some species of *Chrysso*. The species may also be close to the smaller *T. altum* known only from a female.

Theridion rossi sp. n.

Figures 214-216

Holotype. Female from west side of Carpish Mountains, 65 km west of Tingo María, Huánuco, Peru, 17 Oct. 1954 (E. I. Schlinger, E. S. Ross), in the California Academy of Sciences. The species is named after Dr. E. S. Ross, its collector.

Description. The whole spider is light yellowish, the only pigment being in the eyes. Anterior median eyes slightly smaller

than others, more than two diameters apart, one and one-half diameters from laterals. Posterior median eyes two-thirds diameter apart, one and one-quarter from laterals. Chelicerae with two teeth on anterior margin. Abdomen very soft. Total length 3.7 mm. Carapace 1.4 mm long, 1.1 mm wide. First femur, 4.1 mm; patella and tibia, 4.0 mm; metatarsus, 4.3 mm; tarsus, 1.4 mm. Second patella and tibia, 2.2 mm; third, 1.1 mm; fourth, 2.2 mm.

Diagnosis. This species may be related to *T. jamaicense* Levi and *T. antillanum* Simon; it differs, however, in the structure of the epigynum (Figs. 214, 216). The seminal receptacles are embedded on each end of the sclerotized area (Fig. 215). However, since only one specimen was available this could not be studied in detail. The projecting epigynum is divided by a deep transverse posterior groove (Figs. 214, 216).

Theridion impigrum Keyserling

Figures 217-218

Theridium impegrum Keyserling, 1886, Die Spinnen Amerikas, Theridiidae, 2(2): 232, pl. 20, fig. 286, ♀. Female holotype from Blumenau, Santa Catarina, Brazil, in the British Museum, examined.

Only fragments of the type are in existence. The name should be *impigrum*, meaning "untiring."

Theridion paraense sp. n.

Figures 219-220

Holotype. Female from Belém, Pará, Brazil (M. de Mathan), in the Muséum National d'Histoire Naturelle, Paris (no. 4239). The species is named after the type locality.

Description. Carapace yellow-brown with a central dorsal dusky mark and a fine gray line around edge. Sternum yellow-brown. Legs yellow-brown. Abdomen brownish white with two fine lines on anterior portion of dorsum. The two lines cross each other at right angles. There is some gray on venter. Eyes subequal in size. Anterior median eyes two-thirds diameter apart, almost touching laterals. Posterior median eyes one diameter apart, two-thirds diameter from laterals. One blunt tooth on anterior margin of chelicerae. Total length 2.7 mm. Carapace 1.0 mm long, 0.9 mm wide. First femur, 1.4 mm; patella and tibia, 1.4 mm; metatarsus, 1.2 mm; tarsus, 0.5 mm. Second patella and tibia, 0.8 mm; third, 0.7 mm; fourth, 1.2 mm.

Diagnosis. The epigynum of this indistinct species has a central depression with a posterior projecting lip (Fig. 220). The anterior thickest portion of the swelling is opaque and the posterior portion is slightly transparent showing the two heavily sclerotized ducts. The opening faces anteriorly into the depression (Fig. 220). Its relationship to other species is unknown.

Theridion nigriceps Keyserling
Figures 221-224

Theridium nigriceps Keyserling, 1891, Die Spinnen Amerikas, Brasilianische Spinnen, 3: 188, pl. 6, fig. 134, ♀. Female holotype from Botucatu, Est. São Paulo, Brazil, in the British Museum, examined. — Göldi, 1892, Mitt. Osterlande, neue Folge, 5: 37.

Description. Carapace yellow, head region black. In some just eye region black, in others the black spot reaches one-third length of carapace. Sternum yellow. Legs yellowish with distal segments darker to brown. Abdomen yellowish white without marks. Eyes subequal in size. Anterior median eyes their diameter apart, two-thirds diameter from laterals. Posterior median eyes a little less than their diameter apart, one diameter from laterals. Total length 1.6 mm. Carapace 0.55 mm long, 0.55 mm wide. First femur, 1.16 mm; patella and tibia, 1.04 mm; metatarsus, 0.81 mm; tarsus, 0.45 mm. Second patella and tibia, 0.81 mm; third, 0.65 mm; fourth, 0.79 mm.

Figures 221, 222 were made from the holotype.

Record. Brazil. Minas Gerais: Caraça, 3 ♀ (E. Gounelle, MNHN).

Theridion opolon sp. n.
Figures 225, 258-259

Holotype. Male from Teresópolis, 900-1000 m elev., Est. Rio de Janeiro, Brazil, March 1946 (H. Sick), in the American Museum of Natural History. The specific name is an arbitrary combination of letters.

Description. Carapace orange-yellow, that of female yellow-white with some duskiness on carapace and sternum. Legs orange-yellow. Abdomen white with a well defined black patch above spinnerets on dorsum, that of female with three black patches in a line, the middle one the smallest, each patch having a small amount of white pigment in center. Eyes subequal in size in males, in females anterior medians slightly smaller than others.

Anterior median eyes less than their diameter apart, almost touching laterals. Posterior eyes a little more than their radius apart. The first femora of male enlarged and swollen. Total length of female 1.3 mm. Carapace 0.62 mm long, 0.52 mm wide. First femur, 0.78 mm; patella and tibia, 0.78 mm; metatarsus, 0.47 mm; tarsus, 0.38 mm. Second patella and tibia, 0.58 mm; third, 0.39 mm; fourth, 0.65 mm. Total length of male 1.3 mm. Carapace 0.65 mm long, 0.59 mm wide. First femur, 0.92 mm; patella and tibia, 1.02 mm; metatarsus, 0.53 mm; tarsus, 0.33 mm. Second patella and tibia, 0.71 mm; third, 0.47 mm; fourth, 0.65 mm.

Diagnosis. This species is close to *T. atropunctatum* and also has the first leg of the male enlarged. The palpus (Fig. 225), however, is very different, lightly sclerotized and very difficult to study.

Record. Brazil. One ♀ collected at the same place and date as ♂, also marked with a black spot above spinnerets. *São Paulo.* Ipiranga, São Paulo, Jan. 1959, ♀ (A. M. Nadler, AMNH). *Santa Catarina:* ♀ (Bergroth, MNHN).

Theridion rubiginosum Keyserling

Figure 226

Theridium rubiginosum Keyserling, 1884, Die Spinnen Amerikas, Theridiidae, 2(1): 80, pl. 4, fig. 49, ♂. Male holotype from Paraná, [Brazil], in the Hope Department of Entomology, Oxford University, examined.

Theridion aporum sp. n.

Figures 227, 228

Holotype. Male from Caraça, Minas Gerais, Brazil (E. Gounelle), in the Muséum National d'Histoire Naturelle, Paris (no. 9208). The specific name is an arbitrary combination of letters.

Description. Carapace orange-brown. Sternum orange. Femora of first and second legs, which are sclerotized, orange-brown; other legs and segments yellowish. Abdomen grayish with four black spots on dorsum and a white crescent between (Fig. 228). Anterior median eyes smaller than others, their radius apart, touching laterals. Posterior median eyes one-third diameter apart, their radius from laterals. Abdomen with two anterior sclerotized stridulating areas above pedicel. Total length 1.4 mm. Carapace 0.65 mm long, 0.65 mm wide. First femur, 1.32

mm; patella and tibia, 1.33 mm; metatarsus, 0.78 mm; tarsus, 0.41 mm. Second patella and tibia, 1.04 mm; third, 0.60 mm; fourth, 0.85 mm.

Diagnosis. The sclerotized conductor, which extends beyond the cymbium (Fig. 227), separates this species from other *Theridion*. The species may belong to a group whose females have the abdomen wider than long; its relationship is uncertain.

Theridion osprum sp. n.

Figure 229

Holotype. Male from Rancho Grande, Aragua, Venezuela, 4 March 1959 (A. M. Nadler), in the American Museum of Natural History. The specific name is an arbitrary combination of letters.

Description. Carapace yellow-white, reddish in eye region. Sternum, legs yellow-white. Abdomen grayish with a wide, white band across dorsum. Anterior median eyes slightly smaller than others, their radius apart, almost touching laterals. Posterior median eyes one-third diameter apart, their radius from laterals. Chelicerae with tubercles on anterior face near base. Abdomen as wide as long, subtriangular. Total length 1.3 mm. Carapace 0.65 mm long, 0.57 mm wide. First femur, 1.17 mm; patella and tibia, 1.25 mm; metatarsus, 1.01 mm; tarsus, 0.39 mm. Third patella and tibia, 0.49 mm; fourth, 0.71 mm.

Diagnosis. The palpus (Fig. 229), which has a long median apophysis supporting a translucent embolus, separates this species from other *Theridion*. It is not close to any species known.

Theridion urucum sp. n.

Figure 230

Holotype. Male from Urucum, near Corumbá, Est. Mato Grosso, Brazil, 8 Jan. 1959 (A. M. Nadler), in the American Museum of Natural History. The specific name is a noun in apposition after the type locality.

Description. Carapace yellow-white, dusky on sides and with gray border. Eye region reddish. Sternum, legs yellow-white. Dorsum of abdomen with white pigment spots, gray on sides. Venter gray in genital area. Eyes subequal in size. Anterior median eyes two-thirds their diameter apart, almost touching laterals. Posterior eyes their radius apart. Abdomen subtriangular; it might have a hump. Total length 1.4 mm. Carapace 0.55 mm long, 0.58 mm wide. First femur, 1.62 mm; patella and tibia,

1.70 mm; metatarsus, 1.33 mm; tarsus, 0.60 mm. Second patella and tibia, 1.01 mm; third, 0.61 mm; fourth, 0.96 mm.

Diagnosis. The transparent palpus is difficult to study, since the sclerites are hard to delineate. The palpus (Fig. 230) is very distinct from that of other species of *Theridion*. The abdomen might have a hump in the female, suggesting that this species may belong to *Chrysso*.

Theridion stannardi sp. n.

Figure 231

Holotype. Male from Finca Mante Libano, Ososingo Valley, Chiapas, Mexico, 4 July 1950 (C., M. Goodnight, L. Stannard), in the American Museum of Natural History. The species is named after Dr. L. Stannard, its collector.

Description. Carapace olive-yellow with a short median, gray line. Sternum olive-yellow with some gray. Legs olive-yellow with very faint indications of bands. Abdomen gray with a white median band, narrow in front and behind; black on sides. Venter with a white spot between the epigynum and spinnerets. Anterior median eyes slightly larger than others, two-thirds their diameter apart, one-quarter from laterals. Posterior median eyes their radius apart, two-thirds diameter from laterals. Total length 1.8 mm. Carapace 0.81 mm long, 0.71 mm wide. First femur, 1.13 mm; patella and tibia, 1.30 mm; metatarsus, 1.00 mm; tarsus, 0.52 mm. Second patella and tibia, 0.92 mm; third, 0.60 mm; fourth, 0.92 mm.

Diagnosis. The structure, particularly the distal tip of the palpus (Fig. 231) separates this species from *T. lathropi* Levi found in Panama.

Theridion beebei sp. n.

Figure 234

Holotype. Male from Rancho Grande, near Maracay, Venezuela, 31 Aug. 1946 (W. Beebe), in the American Museum of Natural History. The species is named after Dr. W. Beebe, naturalist, and its collector.

Description. Carapace, sternum, legs yellow-brown. Abdomen dorsum black with a median white band having a wavy border; band narrowest in front and again narrowing behind. Venter with a white spot between spinnerets and epigynum. Eyes subequal in size. Anterior median eyes two-thirds diameter apart,

almost touching laterals. Posterior median eyes two-thirds diameter apart, one diameter from laterals. Total length 2.2 mm. Carapace 0.98 mm long, 0.84 mm wide. First femur, 1.32 mm; patella and tibia, 1.43 mm; metatarsus, 1.04 mm; tarsus, 0.49 mm. Second patella and tibia, 1.08 mm; third, 0.75 mm; fourth, 1.05 mm.

Diagnosis. This species seems close to *T. marvum*, but differs by the palpal sclerites (Fig. 234). The palpus resembles that of members of the genus *Achaearanea*. However, it is more complex; the embolus and median apophysis are separated and a radix appears to be present.

Theridion cuyutlan sp. n.

Figure 235

Holotype. Male from Cuyutlán, Colima, Mexico, 11 Jan. 1943 (F. Bonet), in the American Museum of Natural History. The specific name is a noun in apposition after the type locality.

Description. Carapace yellowish, olive on sides. Sternum olive-gray, yellow anteriorly. Legs olive-yellow. Abdomen gray to black with a series of three well defined unpigmented stripes, as wide as intermediate areas, on each side. Also an anterior median spot and colorless spot above spinnerets. Eyes subequal in size. Anterior median eyes one diameter apart, almost touching laterals. Posterior eyes three-quarters diameter apart. Total length 1.7 mm. Carapace 0.75 mm long, 0.69 mm wide. First femur, 1.23 mm; patella and tibia, 1.30 mm; metatarsus, 1.01 mm. Second patella and tibia, 0.91 mm; third, 0.62 mm; fourth, 0.88 mm.

Diagnosis. The generic placement is uncertain; since only one specimen was available, the palpus was not expanded for examination. It is thought to be close to *T. panamense* Levi; the palpal structure (Fig. 235), however, separates it.

Theridion panamense Levi

Theridion panamense Levi, 1959, Bull. Mus. Comp. Zool., 121: 123, figs. 263-267, ♀, ♂. Male holotype from El Volcán, Panama, in the Museum of Comparative Zoology.

Distribution. Panama to Ecuador.

Additional records. Ecuador. El Oro: Río Jubanes, Pasaje, ♂ (A. Wells), doubtful det.

Theridion signaculum Levi

Map 3

Theridion signaculum Levi, 1959, Bull. Mus. Comp. Zool., 121: 134, figs. 301-302, 333, ♀, ♂. Male holotype from Panama Canal Zone, in the Museum of Comparative Zoology.

Distribution. Panama to northern Brazil (Map 3).

Additional record. Brazil. Pará: Municipal Park, Belém, 12 Feb. 1959, ♀, ♂ (A. M. Nadler, AMNH).

Theridion olaup sp. n.

Figure 236

Holotype. Male from Forest Reservation, Cid. São Paulo, Brazil, 16 Jan. 1959 (A. M. Nadler), in the American Museum of Natural History. The specific name is an arbitrary combination of letters.

Description. Carapace yellow-white, head and first legs slightly darker, brownish. Abdomen whitish with three pairs of round black spots on dorsum in two parallel rows. Anterior median eyes larger than others, a little more than their diameters apart, almost touching laterals. Posterior median eyes one and one-half diameters apart, almost one diameter from laterals. Abdomen longer than wide. Total length 1.7 mm. Carapace 0.82 mm long, 0.68 mm wide. First femur, 1.08 mm; patella and tibia, 1.24 mm; metatarsus, 0.86 mm; tarsus, 0.48 mm. Second patella and tibia, 0.82 mm; third, 0.48 mm; fourth, 0.72 mm.

Diagnosis. The palpus is very lightly sclerotized and selerites are difficult to delineate (Fig. 236). The palpus is much narrower than that of the related *T. nudum*.

Record. One ♂ paratype (with palpus expanded) collected with holotype.

Theridion exlinae sp. n.

Figures 237-240

Holotype. Male from Sullana, Piura, Peru, 5 Oct. 1941 (H. E. and D. L. Frizzell), in the Museum of Comparative Zoology. The species is named after Mrs. Frizzell (Dr. H. Exline).

Description. Carapace, sternum, legs yellow. Abdomen gray with large irregular black patches that are more extensive on venter; sometimes many small white spots on dorsum. Anterior median eyes slightly smaller than others, their diameter apart

and two-thirds diameter from laterals. Posterior eyes one diameter apart. Chelicerae with one anterior tooth. Total length of female 2.8 mm. Carapace 0.87 mm long, 0.78 mm wide. First femur, 1.10 mm; patella and tibia, 1.13 mm; metatarsus, 0.91 mm; tarsus, 0.52 mm. Second patella and tibia, 0.95 mm; third, 0.73 mm; fourth, 1.10 mm. Total length of male 2.8 mm. Carapace 1.04 mm long, 0.84 mm wide. First femur, 1.17 mm; patella and tibia, 1.30 mm; metatarsus, 1.04 mm; tarsus, 0.42 mm. Second patella and tibia, 1.06 mm; third, 1.03 mm; fourth, 1.04 mm.

The male has the chelicerae enlarged and has one large tooth. The anterior of the male abdomen has a very small stridulating area, a structure usually not present in this genus.

Diagnosis. The epigynum of this species is indistinct; a lighter area sometimes with two slightly sclerotized openings far apart on the anterior, usually openings just apparent as dark spots (Fig. 240). Palpus (Fig. 237) very small, probably with all sclerites present. Femora of palpus with a thorn (Fig. 238). The genitalia as well as the thorn on the palpal femora ally this species to *T. bergi*, the longer fertilization ducts and shorter legs separate it. The possibility that the two belong to the same species should be considered when additional specimens become available.

Records. Ecuador. Guayas: Milagro, 10 May 1942 (H. E., D. L. Frizzell). *Tungurahua.* Río Topo, 17 June 1943, 3 ♀ paratypes (H. E., D. L. Frizzell). *Peru. Piura:* Sullana, 5 Oct. 1941, ♀ paratypes (H. E., D. L. Frizzell); Higueron, Las Lomas, 29 July 1941, ♀ ♂ paratypes (H. E., D. L. Frizzell); Chira River, 26 Jan. 1941, ♀ ♂ paratypes (H. E., D. L. Frizzell); Mallares, Chira River, 6 April 1941 (H. E. Frizzell).

Theridion bergi sp. n.

Figures 86-87

Holotype. Female from Buenos Aires, Argentina (C. Berg), in the Muséum National d'Histoire Naturelle, Paris (no. 4081). The species is named after its collector, former director of the Museo Argentino de Ciencas Naturales.

Description. Carapace yellowish with median longitudinal gray band of variable width in different specimens. Sternum, legs yellow. Abdomen gray with two white dorsal longitudinal bands, one on each side, composed of small white pigment spots. Scattered small white pigment spots between. About 6 paired

gray spots in two rows on each side touch the median margin of white bands. Venter dark gray between genital area and spinnerets. Anterior median eyes slightly smaller than others. Posterior median eyes oval in shape. Anterior median eyes one diameter apart, their radius from laterals. Posterior eyes about their diameter apart. Female chelicerae with two teeth on anterior margin. Chelicerae of male enlarged, attenuated with a large boss on inside margin about middle, bearing two teeth. Male palpal femur with a thorn on venter. Total length of female 2.5 mm. Carapace 1.04 mm long, 0.98 mm wide. First femur, 1.42 mm; patella and tibia, 1.61 mm; metatarsus, 1.23 mm; tarsus, 0.60 mm. Second patella and tibia, 1.18 mm; third, 0.87 mm; fourth, 1.28 mm. Total length of male 2.3 mm. Carapace 1.10 mm long, 1.04 mm wide. First femur, 1.32 mm; patella and tibia, 1.72 mm; metatarsus, 1.17 mm; tarsus, 0.54 mm. Second patella and tibia, 1.12 mm; third, 0.86 mm; fourth, 1.12 mm.

Note. The palpus of the only male specimen available was in expanded condition, thus was not illustrated.

Diagnosis. The very simple epigynum, showing the lips of two openings (Fig. 87) separates *T. bergi* from other species. The longer legs and shorter fertilization ducts separate it from *T. exlinae* of Peru and Ecuador. The males of both species have a thorn on the femur, and enlarged chelicerae.

Records. Paraguay. One ♀ (Germain, MNHN). *Argentina.* Buenos Aires: 1 ♂, 3 ♀ paratypes (C. Berg, MNHN).

Theridion isorium sp. n.

Figures 241-243

Holotype. Female from Divisoria, Dept. Huánuco, 1700 m elev., Peru, 23 Sept.-3 Oct. 1946 (F. Woytkowski), in the American Museum of Natural History. The specific name is an arbitrary combination of letters.

Description. Carapace, sternum, legs dark gray-brown; coxae and proximal ends of femora yellow-white. Abdomen black with some white stripes on dorsum (Fig. 241); venter with no light marks. Anterior median eyes slightly larger than others, three-quarters their diameter apart, almost touching laterals. Posterior median eyes one diameter apart, three-quarters diameter from laterals. Total length 1.5 mm. Carapace 0.71 mm long, 0.55 mm wide. First femur, 0.88 mm; patella and tibia, 0.83 mm; metatarsus, 0.57 mm; tarsus, 0.42 mm. Second patella and tibia, 0.65 mm; third, 0.50 mm; fourth, 0.75 mm.

Diagnosis. The epigynum, which is an indistinct white area in a heavily pigmented region, has no lip (Fig. 243). The loops of the ducts and the color of the abdomen (Fig. 241) will separate this species from other species of *Theridion*, including *T. exlinae*.

Record. Peru. Huánuco: 100 km E of Tingo María, 5 Oct. 1954, ♀.

Theridion plaumanni sp. n.

Figures 244-248; Map 3

Holotype. Male from Nova Teutonia, lat 27°11′S, long 52°23′W, Santa Catarina, Brazil (F. Plaumann), in the Senckenberg Museum (no. RII/13468/1). The species is named after the collector.

Description. Except for pigment present in eyes, this species is without pigment in alcohol and is very lightly sclerotized. The sclerotized areas are yellowish, the soft ones lighter. Eyes subequal in size. Anterior median eyes one and one-quarter diameters apart, one-third diameter from laterals. Posterior median eyes one and one-half diameters apart, one diameter from laterals. Chelicerae of male with a hump, almost in middle and one large anterior tooth, fangs very heavy and large, two-thirds length of outside chelicerae. Total length of female from Venezuela 2.3 mm. Carapace 0.8 mm long, 0.7 mm wide. First femur, 2.4 mm; patella and tibia, 2.3 mm; metatarsus, 1.8 mm; tarsus, 0.7 mm. Third patella and tibia, 0.9 mm; fourth, 1.2 mm. Total length of male 2.2 mm. Carapace 0.7 mm long, 0.7 mm wide. First femur, 3.2 mm; patella and tibia, 3.1 mm; metatarsus, 2.5 mm; tarsus, 0.6 mm. Second patella and tibia, 1.7 mm; third, 0.9 mm; fourth, 1.3 mm.

Diagnosis. The structure of the palpus (Fig. 244) separates this species from *T. exlinae*. The epigynum has an indistinct oval depression with the connecting duct showing anteriorly and slightly to the sides (Figs. 246, 248). The larger connecting duct loops probably separate this species from *T. excavatum* O. P.-Cambridge.

Records. Venezuela. Aragua: Tovar, 1888, ♀ ♂ (E. Simon, MNHN). *Dist. Fed.:* Caracas, 1887-1888, ♀ (E. Simon, MNHN). *Brazil. Minas Gerais:* Caraça, ♀ ♂ (E. Gounelle, MNHN). *São Paulo:* Botanical Gardens, São Paulo, Jan. 1959, ♀ ♂ (A. M. Nadler, AMNH).

Theridion zonarium Keyserling
Figures 249-251

Theridium zonarium Keyserling, 1884, Die Spinnen Amerikas, Theridiidae, 2(1): 79, pl. 4, fig. 48, ♀. Female holotype from Guadaloupa [Guadalupe, Libertad], Peru, in the Polish Academy of Sciences, Warsaw, examined.

Abdomen with a median dorsal triangular white band pointing posteriorly; from the band branch 3-4 narrow white lines to the sides, separating off a series of 4-5 dark brown spots on each side. Venter with a white line across, anterior to pedicel, and a pair of brown spots anterior to spinnerets. Chelicerae with two teeth on anterior margin. The epigynum is small (Fig. 251). Carapace 2.1 mm long, first patella and tibia, 3.7 mm.

Figures 249-251 were prepared from the holotype.

Record. Peru. Lambayeque: 34 km E of Olmos, 20 Jan. 1955, ♀ (E. I. Schlinger, E. S. Ross, CAS).

Theridion baltasarense sp. n.
Figures 252-253

Holotype. Female from Baltasar, Windward Island, Lesser Antilles, 250 ft. [75 m elev.], second growth by a stream, in the British Museum. The species is named after the type locality.

Description. Carapace yellow, dusky towards the sides. Legs yellowish with narrow dusky bands. Abdomen dorsum has a median white band having jagged margins, on a black background; sides with white irregular patches on black; venter with a central white spot in center on a black background. Eyes subequal in size. Anterior median eyes somewhat less than one diameter apart, almost touching laterals. Posterior median eyes less than one diameter apart. Total length 2.00 mm. Carapace 0.98 mm long, 0.86 mm wide. First femur, 1.23 mm; patella and tibia, 1.32 mm; metatarsus, 0.92 mm; tarsus, 0.55 mm. Second patella and tibia, 0.98 mm; third, 0.71 mm; fourth, 1.12 mm.

Diagnosis. The shallow depression (Fig. 253) of the epigynum separates this species from *T. paidiscum;* the internal genitalia are similar.

Record. Lesser Antilles: Baltasar, 1 ♀ paratype.

Theridion pigrum Keyserling
Figures 254-255

Theridium pigrum Keyserling, 1886, Die Spinnen Amerikas, Theridiidae, 2(2): 232, pl. 20, fig. 287, ♀. Female holotype from Blumenau, [Santa Catarina], Brazil, in the Naturhistorisches Museum, Vienna, examined.

Since several species described by Keyserling and belonging to the Vienna Museum were actually mislabelled European specimens, it is possible that this is a European species not known to me.

Theridion agrarium sp. n.

Figures 256-257

Holotype. Female from Agronomical Institute, Belém, Est. Pará, Brazil, 13 Feb. 1959 (A. M. Nadler), in the American Museum of Natural History. The specific name is an adjective from agriculture.

Description. Carapace yellow-brown, grayish on sides. Sternum olive. Legs yellow-white with black spots on venter. Abdomen gray to black with two dorsal jagged white lines, more or less parallel, fusing in front and behind as in *T. petrum* Levi; from white lines on each side two lines going down side. Borders of white lines darker than rest of dorsum. Venter with a central white spot between epigynum and spinnerets. Eyes subequal in size. Anterior median eyes two-thirds diameter apart, almost touching laterals. Posterior median eyes one-third diameter apart, their radius from laterals. Total length 1.3 mm. Carapace 0.59 mm long, 0.49 mm wide. First femur, 0.52 mm; patella and tibia, 0.52 mm; metatarsus, 0.32 mm; tarsus, 0.26 mm. Second patella and tibia, 0.41 mm; third, 0.36 mm.

Diagnosis. The epigynum has a dark, raised ridge at each end of which there is an opening of the thin connecting ducts. The ridge (Fig. 257) and shorter ducts separate this species from *T. chilapa* Levi, and *T. armouri* Levi.

Theridion weyrauchi sp. n.

Figures 260-262

Holotype. Female from Cutervo, 2800 m, Cajamarca, Peru, 22 June 1956 (W. Weyrauch), in the Museum of Comparative Zoology. The species is named after the collector.

Description. Carapace black, sternum dark brown, legs yellowish white with darker brown and black rings. Dorsum of abdomen black, gray and white (Fig. 262); two white spots side by side between genital groove and spinnerets on venter. Anterior median eyes slightly smaller than others, their diameter apart, their radius from laterals. Posterior eyes their diameter apart. Total length 2.4 mm. Carapace 1.04 mm long, 0.93 mm

wide. First femur, 1.36 mm; patella and tibia, 1.48 mm; metatarsus, 1.00 mm; tarsus, 0.55 mm. Second patella and tibia, 1.04 mm; third, 0.78 mm; fourth, 1.10 mm.

Diagnosis. The epigynum (Fig. 261), which has a very small knob in a light area in turn surrounded by dark pigment, separates this species from all other *Theridion.* Not until the male is found will we know to which *Theridion* group this species belongs.

Records. Ecuador. Pichincha: Quito, Santo Domingo Rd., 2000 m, 25 April 1942, 3 ♀ (H. Frizzell, O. L. Haught). *Peru. Cajamarca:* Cutervo, 2800 m, 22 June 1956, ♀ paratype (W. Weyrauch).

Theridion micheneri sp. n.

Figures 263-265

Holotype. Female from Madden Forest, Panama, 18 Jan. 1945 (C. D. Michener), in the American Museum of Natural History. The species is named after Dr. C. D. Michener, the collector.

Description. Carapace dark yellow with some gray on sides. Sternum, legs dark yellow. Abdomen almost black with nine white spots. Eyes subequal in size. Anterior median eyes one diameter apart, one-quarter diameter from laterals. Posterior median eyes one diameter apart, their radius from laterals. Total length 2.0 mm. Carapace 0.91 mm long, 0.79 mm wide. First femur, 1.03 mm; patella and tibia, 1.04 mm; metatarsus, 0.78 mm; tarsus, 0.47 mm. Second patella and tibia, 0.80 mm; third, 0.67 mm; fourth, 0.98 mm.

Diagnosis. The epigynum has a prong (Figs. 264, 265) like that of members of the genus *Tidarren. Theridion michencri* can be distinguished by the different shape of the abdomen and the lack of a white stripe on the posterior portion of its dorsum. Only examination of the male genitalia will make placement in *Theridion* certain.

Theridion cochrum sp. n.

Figures 266-269

Holotype. Female from Teresópolis, Est. Rio de Janeiro, 900-1000 m elev., Brazil, March 1946 (H. Sick), in the American Museum of Natural History. The specific name is an arbitrary combination of letters.

Description. Carapace, sternum, legs yellow. Abdomen yellow-white with gray streaks on sides, center of dorsum whitish (Fig. 269). Anterior median eyes slightly larger than others, two-thirds their diameter apart, almost touching laterals. Posterior median eyes one and one-quarter diameter apart, one diameter from laterals. Chelicerae with one blunt tooth on anterior margin. Abdomen elongate (Fig. 269). Total length 3.00 mm. Carapace 1.33 mm long, 1.02 mm wide. First femur, 2.23 mm; patella and tibia, 1.98 mm; metatarsus, 1.74 mm; tarsus, 0.72 mm. Second patella and tibia, 1.44 mm; third, 1.16 mm; fourth, 1.96 mm.

Diagnosis. No other known species of *Theridion* has the abdomen so elongate, resembling that of the genus *Uloborus* (Uloboridae). The epigynum has a knob, and the openings are at the anterior base of the knob. Possibly this species does not belong to the genus; however, until the male is known it has to be placed here.

Theridion topo sp. n.

Figures 270-272

Holotype. Female from Río Topo, Tungurahua, Ecuador, 17 June 1943 (H. E. and D. L. Frizzell), in the Museum of Comparative Zoology. The specific name is a noun in apposition after the type locality.

Description. Carapace brown with mottled darker areas. Sternum brown. Legs brown with darker rings. Abdomen with dorsum black and some lighter indistinct marks, two short white lines on each side, and one white line anterior; venter gray with light areas behind genital groove and on each side of epigastric plate. Eyes subequal in size. Anterior median eyes one diameter apart, two-thirds diameter from laterals. Posterior eyes one diameter apart. Total length 2.2 mm. Carapace 0.93 mm long, 0.81 mm wide. First femur, 1.17 mm; patella and tibia, 1.20 mm; metatarsus, 0.91 mm; tarsus, 0.53 mm. Second patella and tibia, 1.18 mm; third, 0.92 mm; fourth, 1.06 mm.

Diagnosis. The epigynum (Fig. 271) has a very small indistinct hook; the connecting ducts are very fine and transparent. The shape of the hook and the shape of the ducts separate this species from *T. cobanum* Levi and *T. bridgesi* Levi.

Records. Ecuador. Tungurahua: Río Topo, 17 June 1943, ♀ paratype (H. E., D. L. Frizzell).

Theridion lago sp. n.

Figures 273-275

Holotype. Female from Lago Zurucha, 18 km west of Cuenca, Azuay, Ecuador, 16 Feb. 1955 (E. I. Schlinger, E. S. Ross), in the California Academy of Sciences. The specific name is an arbitrary combination of letters.

Description. Carapace, sternum, legs yellow-white. Abdomen black with a white pigment stripe on dorsum (Fig. 273). Eyes subequal in size, quite small. Anterior median eyes one diameter apart, one-quarter diameter from laterals. Posterior eyes their diameter apart. Chelicerae with two teeth on anterior margin. Total length 2.7 mm. Carapace 1.06 mm long, 1.04 mm wide. First femur, 1.38 mm; patella and tibia, 1.27 mm; metatarsus, 1.07 mm; tarsus, 0.62 mm. Second patella and tibia, 1.01 mm; third, 0.65 mm; fourth, 1.10 mm.

Diagnosis. The distinct stripe on the abdomen (Fig. 273) and the epigynum, which has a light depression with opening on small protuberances on each side posteriorly (Fig. 275), are diagnostic. The epigynal area is pigmented. No other *Theridion* species is close to it.

Theridion rufipes Lucas

Map 1

Theridion rufipes Lucas, 1846 [1849], Explor. scient. de l'Algérie, Zool., 2(1): 263, pl. 16, fig. 5, ♀. Female holotype from near Oran, Algiers. — Levi, 1957, Bull. Amer. Mus. Nat. Hist., 112: 56, figs. 188-193, ♀, ♂.

Distribution. Cosmotropical.

Additional records. United States. Florida: Hendry Co.; Monroe Co.; Palm Beach Co. *Honduras. Yoro:* Subirana (Stadelman). *Lesser Antilles. Trinidad:* St. Ann's (M. Nieves). *Venezuela. Aragua:* Maracay (P. C. Vogl, ZSM). *Colombia. Valle:* Buenaventura (D. L. Frizzell). *Ecuador. Guayas:* Salinas; Guayaquil (H. E., D. L. Frizzell). *Peru. Piura:* El Alto (Ewing). *Loreto:* Pucallpa (E. I. Schlinger, E. S. Ross, CAS); Yurac, 110 km E of Tingo María (E. I. Schlinger, E. S. Ross, CAS). *Huánuco:* Santa Teresa, Río Huallaga, 600 m elev. (F. Woytkowski); Cucharas, Valle Huallaga (F. Woytkowski). *Lima:* Lima, in cotton field (W. Weyrauch, AMNH). *Brazil. Pará:* Belém (A. M. Nadler, AMNH). *Pernambuco:* Recife (SMF). *Minas Gerais:* Belo Horizonte (Cornell Univ. Exped.); Minha Serinha, Diamantina (E. Cohn, AMNH). *Est. Rio de*

Janeiro: Mendes (SMF). *Paraná:* Curitiba (N. L. H. Krauss, AMNH). *Santa Catarina:* Nova Teutonia, lat 27°11′S, long 52°23′W (F. Plaumann, SMF). *Paraguay.* (Bohls, BMNH).

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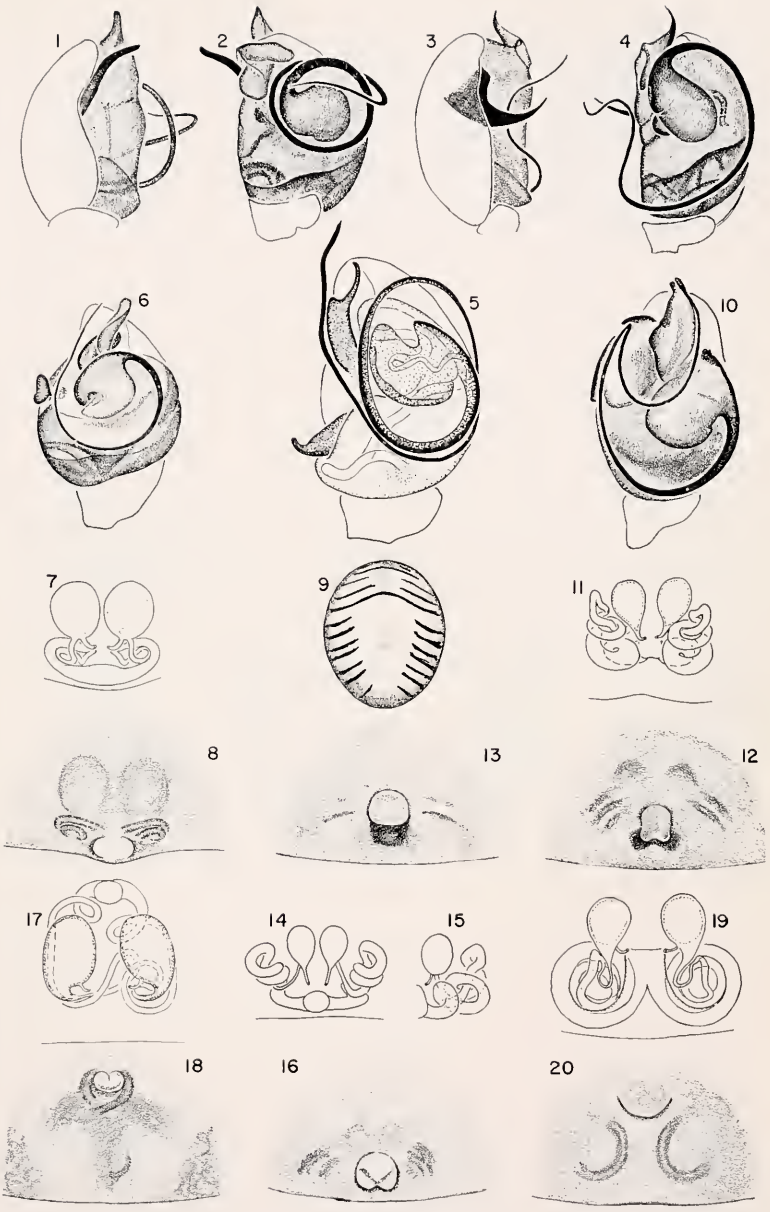
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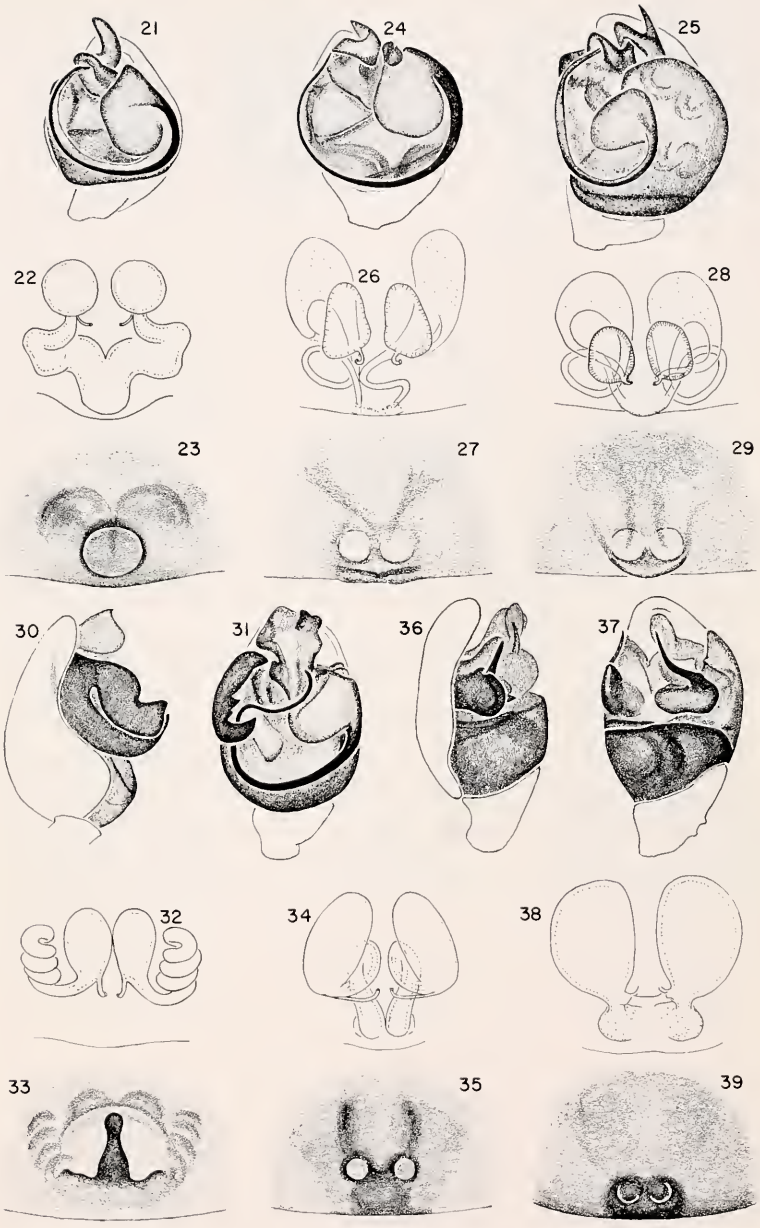
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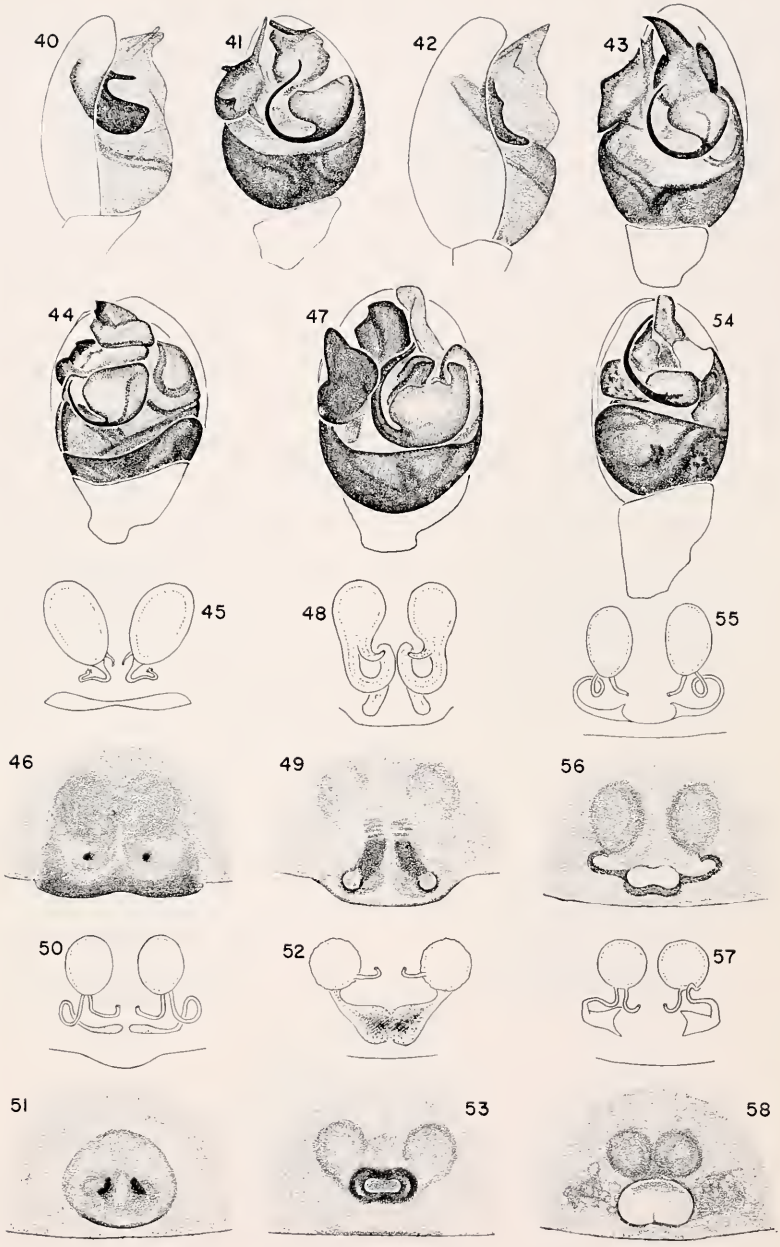
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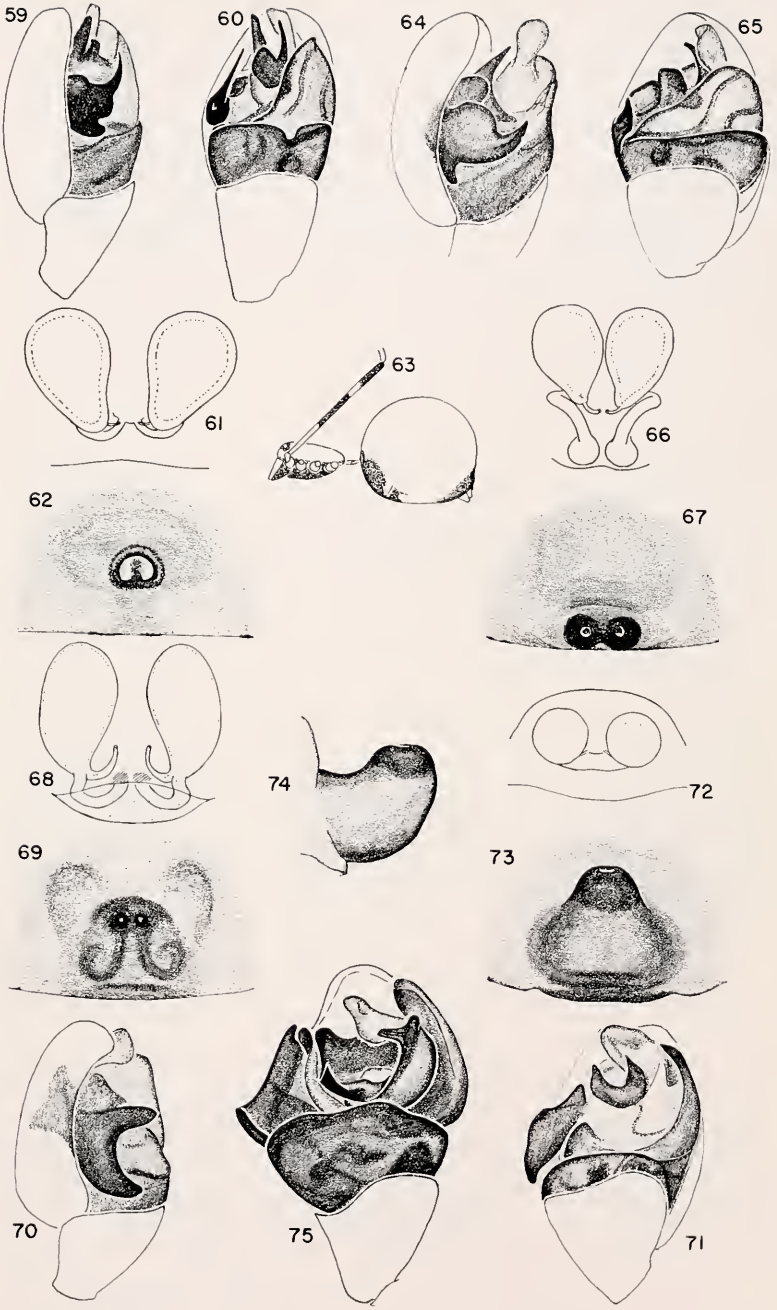
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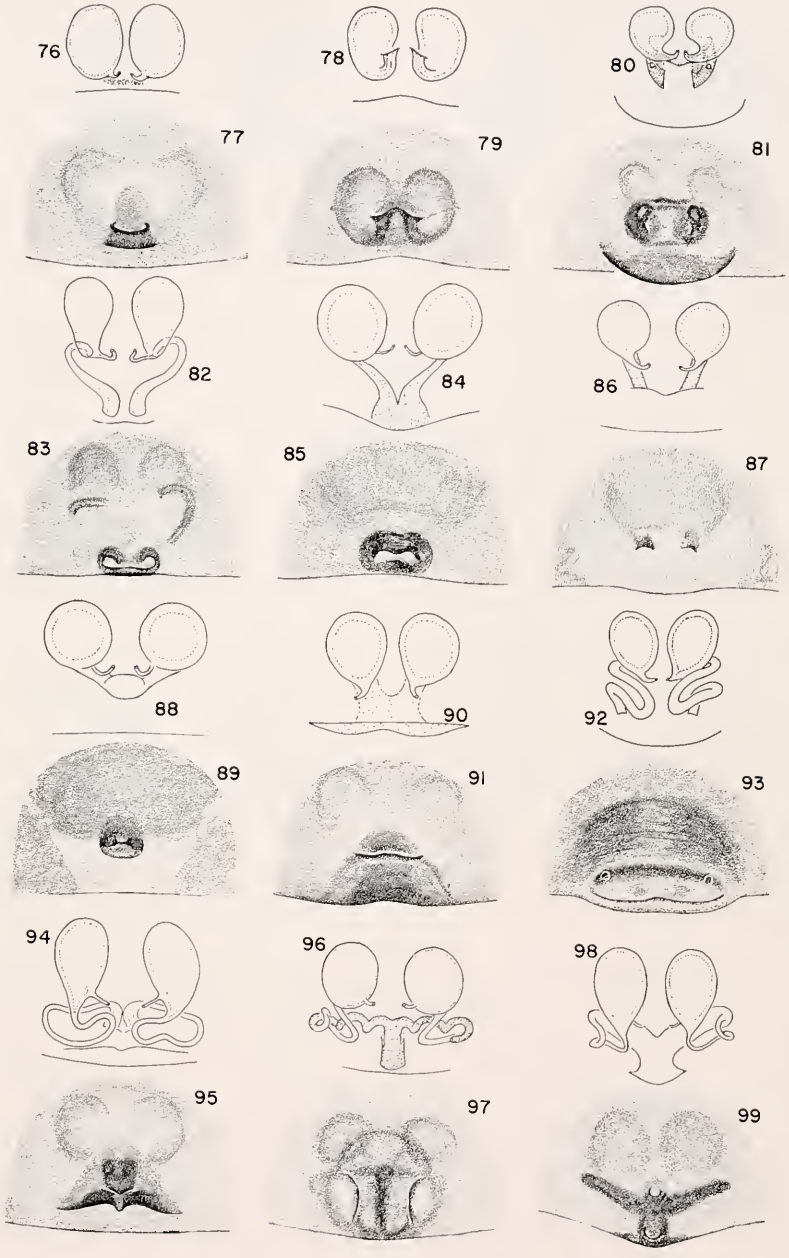
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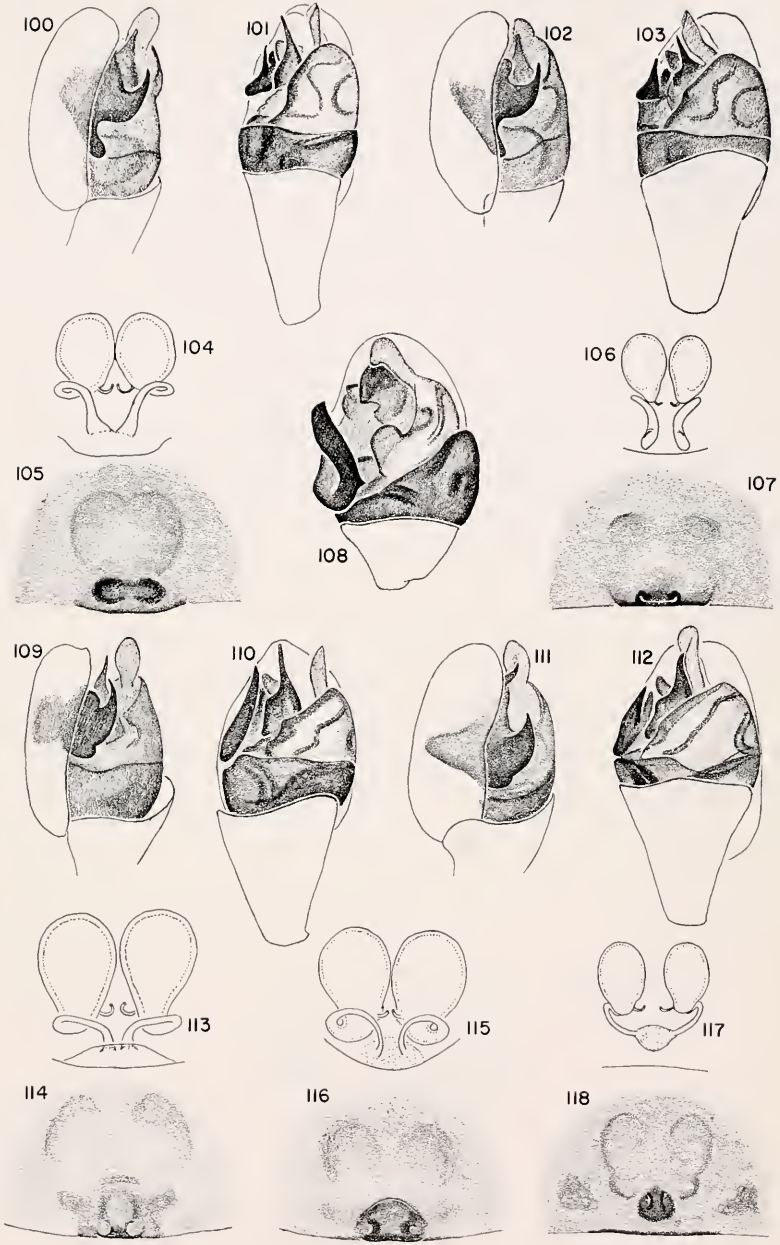
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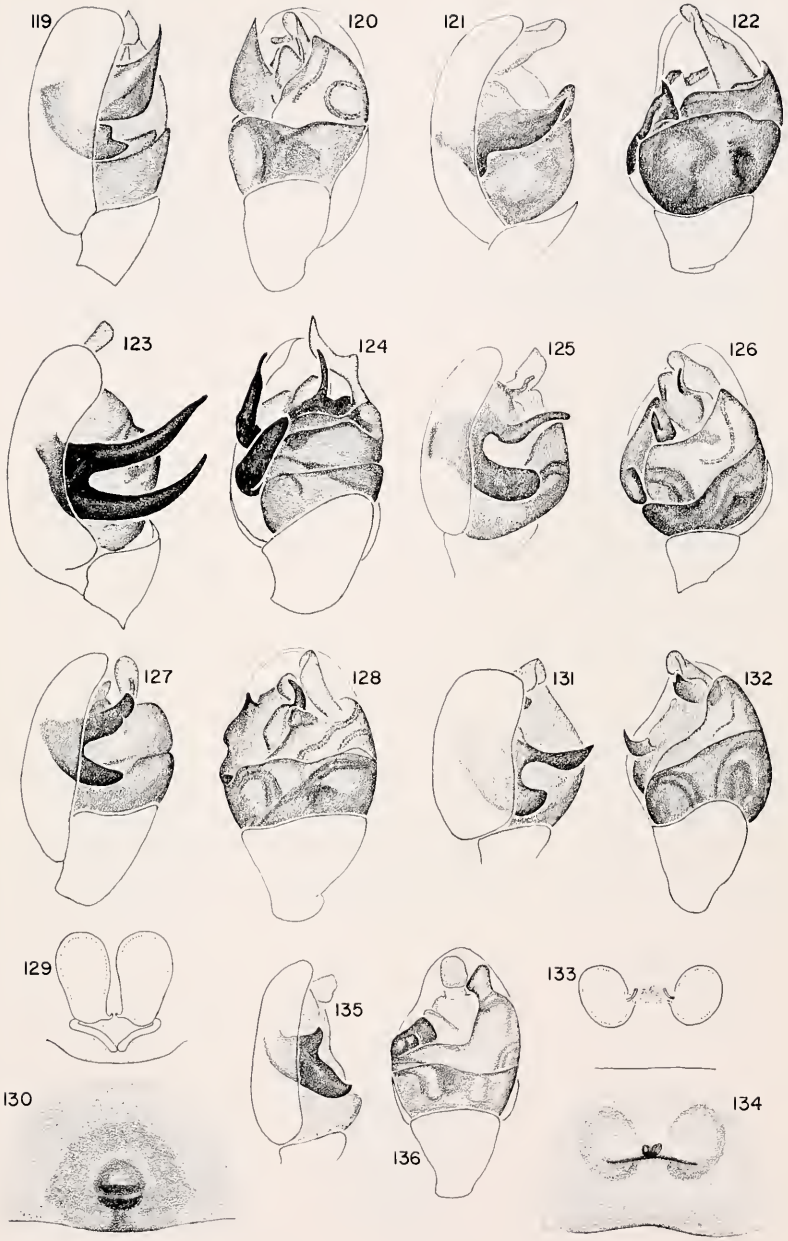
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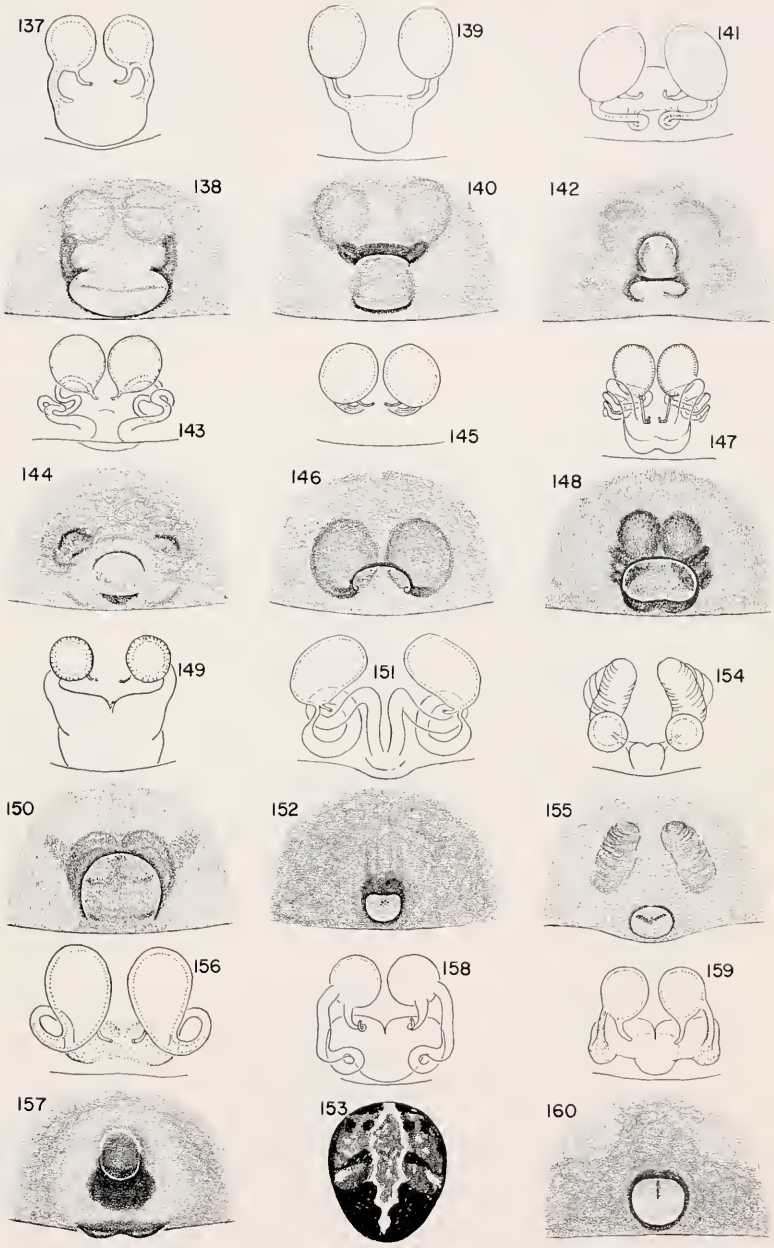
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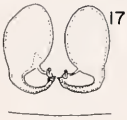
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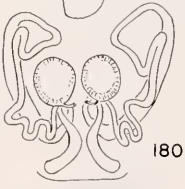
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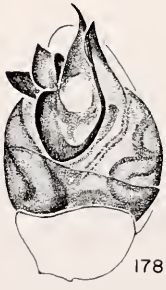
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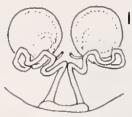
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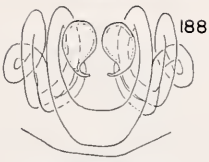
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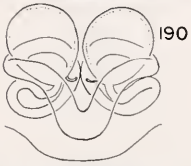
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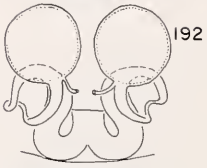
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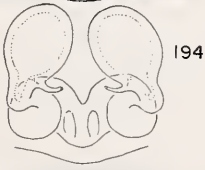
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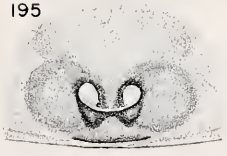
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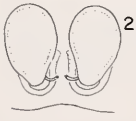
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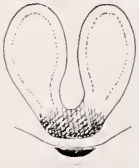
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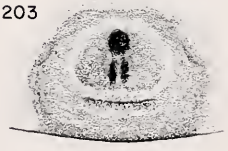
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Fig. 206. *Theridion maranum* sp. n., left palpus.

Figs. 207-208. *T. umbilicus* sp. n. 207. Palpus. 208. Palpus cleared (*Abbreviations*: E, embolus; M, median apophysis).

Fig. 209. *T. aulos* sp. n., palpus.

Fig. 210. *T. nesticum* sp. n., palpus.

Figs. 211-212. *T. altum* sp. n. 211. Female genitalia, dorsal view. 212. Epigynum.

Fig. 213. *T. biezankoi* sp. n., palpus.

Figs. 214-216. *T. rossi* sp. n. 214. Epigynum, lateral view. 215. Female genitalia, dorsal view. 216. Epigynum.

Figs. 217-218. *T. impigrum* Keyserling. 217. Female genitalia, dorsal view. 218. Epigynum.

Figs. 219 220. *T. paracuse* sp. n. 219. Female genitalia, dorsal view. 220. Epigynum.

Figs. 221-224. *T. nigriceps* Keyserling. 221, 223. Female genitalia, dorsal view. 222, 224. Epigynum. 221, 222. (Sao Paulo). 223, 224. (Minas Gerais).

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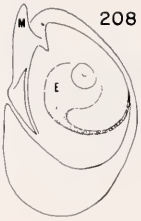

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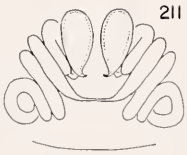
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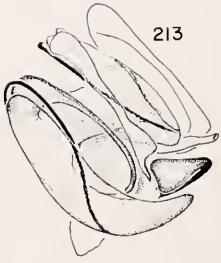
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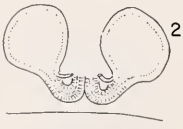
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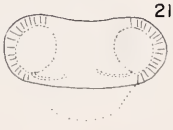
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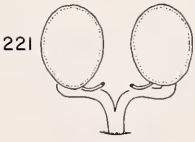
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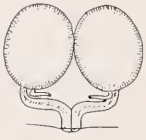
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Fig. 225. *Theridion opolon* sp. n., left palpus.

Fig. 226. *T. rubiginosum* Keyserling, palpus.

Figs. 227-228. *T. aporum* sp. n. 227. Palpus. 228. Male abdomen, dorsal view.

Fig. 229. *T. osprum* sp. n., palpus.

Fig. 230. *T. urucum* sp. n., palpus.

Fig. 231. *T. stannardi* sp. n., palpus.

Figs. 232-233. *T. rampum* sp. n., palpus.

Fig. 234. *T. beebei* sp. n., palpus.

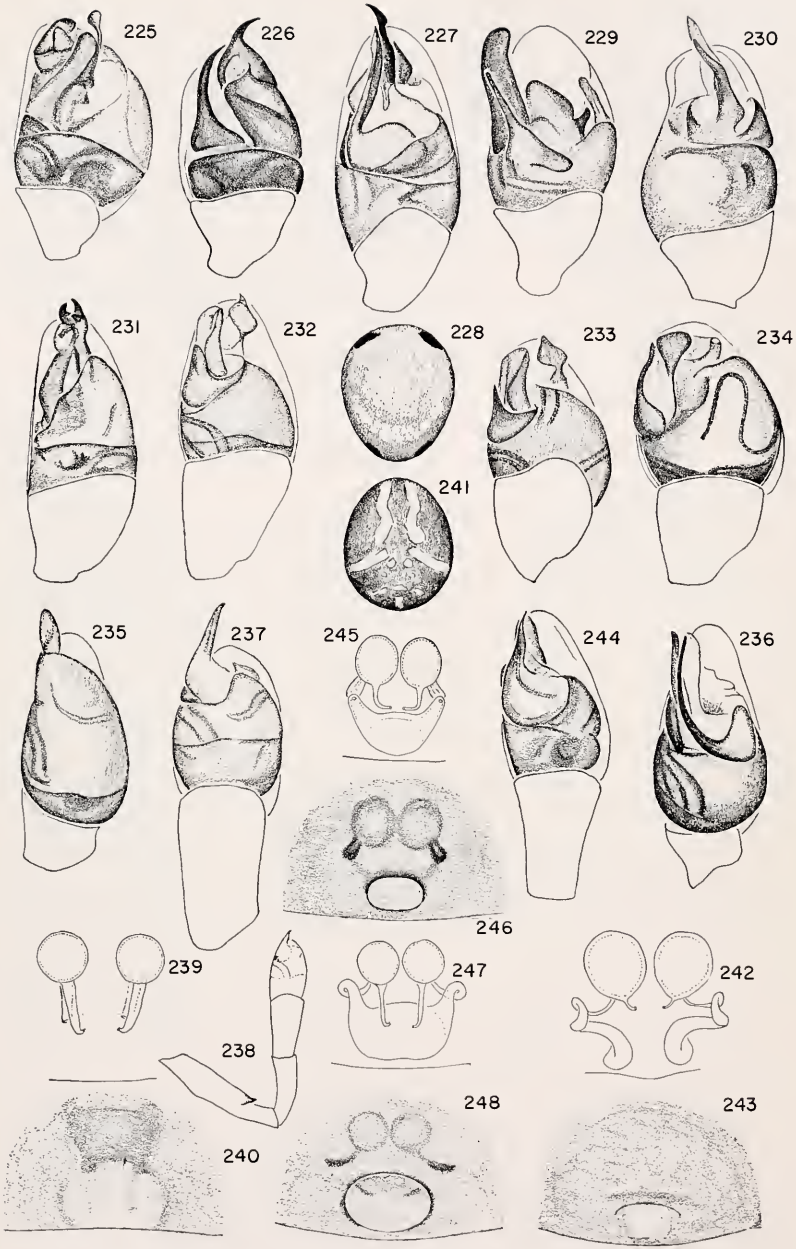
Fig. 235. *T. cayutlan* sp. n., palpus.

Fig. 236. *T. olaup* sp. n., palpus.

Figs. 237-240. *T. carlinae* sp. n. 237, 238. Palpus. 239. Female genitalia, dorsal view. 240. Epigynum.

Figs. 241-243. *T. isorium* sp. n. 241. Female abdomen, dorsal view. 242. Female genitalia, dorsal view. 243. Epigynum.

Figs. 244-248. *T. plaumanni* sp. n. 244. Palpus. 245, 247. Female genitalia, dorsal view. 246, 248. Epigynum. 244-246. (southern Brazil). 247-248. (Venezuela).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Figs. 249-251. *Theridion zonarium* Keyserling. 249. Epigynum, cleared. 250. Female genitalia, dorsal view. 251. Epigynum.

Figs. 252-253. *T. baltasarense* sp. n. 252. Female genitalia, dorsal view. 253. Epigynum.

Figs. 254-255. *T. pigrum* Keyserling. 254. Female genitalia, dorsal view. 255. Epigynum.

Figs. 256-257. *T. agrarium* sp. n. 256. Female genitalia, dorsal view. 257. Epigynum.

Figs. 258-259. *T. opolon* sp. n. 258. Female genitalia, dorsal view. 259. Epigynum.

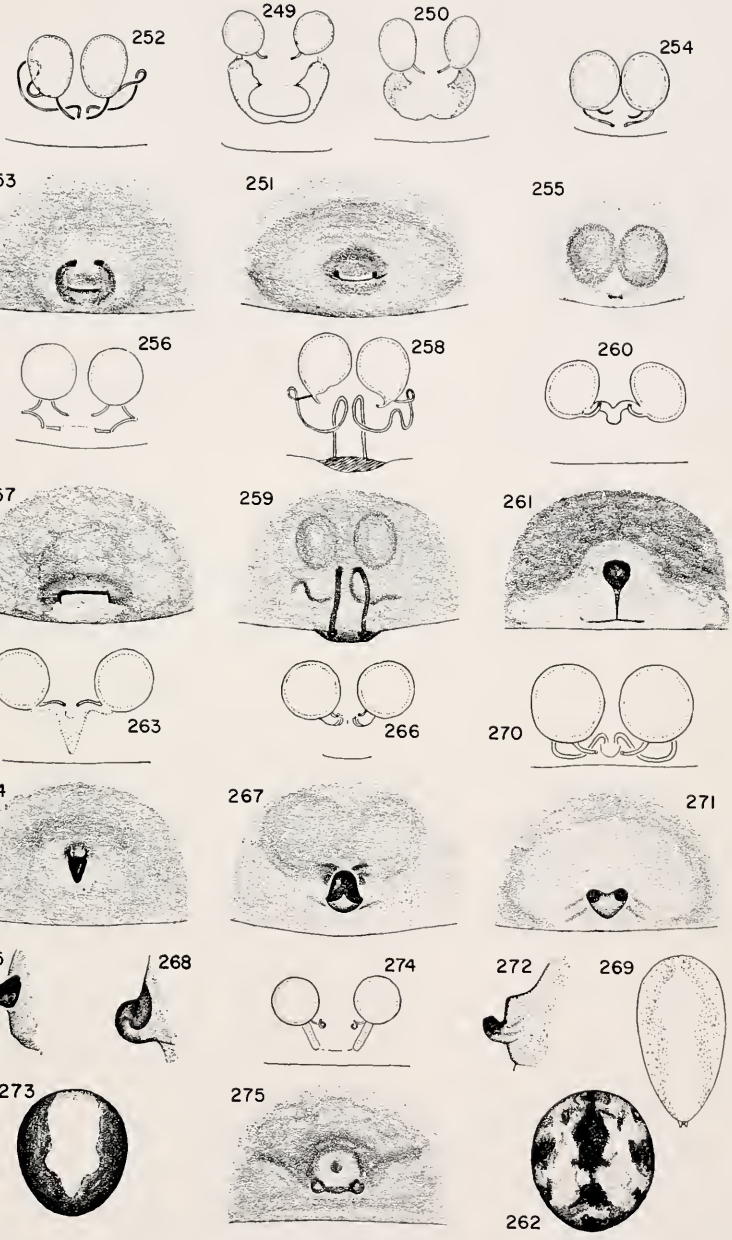
Figs. 260-262. *T. weyrauchi* sp. n. 260. Female genitalia, dorsal view. 261. Epigynum. 262. Female abdomen, dorsal view.

Figs. 263-265. *T. michenori* sp. n. 263. Female genitalia, dorsal view. 264. Epigynum. 265. Epigynum, lateral view.

Figs. 266-269. *T. cochrum* sp. n. 266. Female genitalia, dorsal view. 267. Epigynum. 268. Epigynum, lateral view. 269. Female abdomen.

Figs. 270-272. *T. topo* sp. n. 270. Female genitalia, dorsal view. 271. Epigynum. 272. Epigynum, lateral view

Figs. 273-275. *T. lago* sp. n. 273. Female abdomen, lateral view. 274. Female genitalia, dorsal view. 275. Epigynum.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